AD-A085 658 RESOURCES RESEARCH CORP COLLEGE STATION TX F/G 5/9
AIR FORCE ENLISTED PERSONNEL RETENTION-ACCESSION MODEL.(U)
JUN 80 T R SAVING, R C BATTALIO, A S DE VANY F33615-78-C-0049
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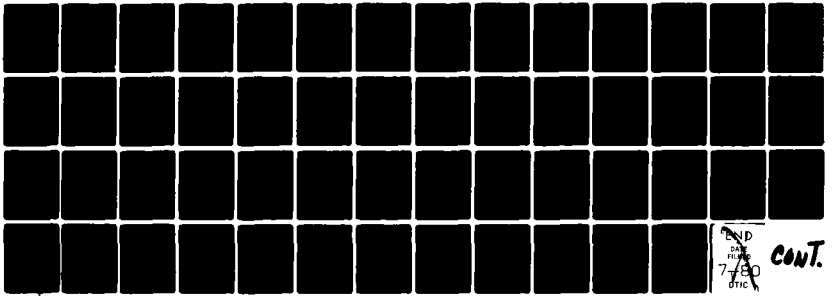

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AIR FORCE

HUMAN RESOURCES

LABORATORY

AIR FORCE ENLISTED PERSONNEL RETENTION-ACCESSION MODEL

By

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June 1980

Final Report

AIR FORCE SYSTEMS COMMAND
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This final report was submitted by Resources Research Corporation, 707 Texas Avenue, Suite 207-D, College Station, Texas 77840, under Contract F33615-78-C-0049, Project ILIR, with the Manpower and Personnel Division, Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235. Mr. John N. Taylor was the Contract Monitor for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFHRL-TR-80-12	2. GOVT ACCESSION NO.: AD-A085 658
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE *(and Subtitle)*: AIR FORCE ENLISTED PERSONNEL RETENTION-ACCESSION MODEL	5. TYPE OF REPORT & PERIOD COVERED: Final rept.
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Thomas R. Saving, Gerald P. Dwyer, Raymond C. Battalio, John K. Kagel, Arthur S. De Vany	8. CONTRACT OR GRANT NUMBER(s): F33615-78-C-0049
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Resources Research Corporation, 707 Texas Avenue, Suite 207-D, College Station, Texas 77840	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61101F; ILIR0743
11. CONTROLLING OFFICE NAME AND ADDRESS: HQ Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235	12. REPORT DATE: June 1980 13. NUMBER OF PAGES: 64
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: Manpower and Personnel Division, Air Force Human Resources Laboratory, Brooks Air Force Base, Texas 78235	15. SECURITY CLASS. *(of this report)*: Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release: distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

accession, AFQT, career, demand, dynamic adjustment, earning profile, elasticity, equilibrium, force level, life-cycle, mean length of stay, personnel pool, quality, relative earnings, rate of change, retention, skill group, supply, training, turnover rate, utility

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report presents the methods of analysis and results of an effort designed to develop a methodology for explaining Air Force accessions and retentions. The analysis was conducted in three stages. First, the life-cycle model of the enlistment decision originally developed in a previous contract was extended and clarified. Second, a new data set was developed. These data are described extensively and plotted to reveal its relation to significant institutional changes that occurred over the 1957 to 1978 period. The data were then used to estimate accession supply equations for each sex, race, and AFQT category. Third, two new theoretical developments are presented. The first of these develops a model of the enlisted force by skill group. The second utilizes the theory of economic dynamics to simulate the adjustment of the enlisted force to changes in pertinent variables.

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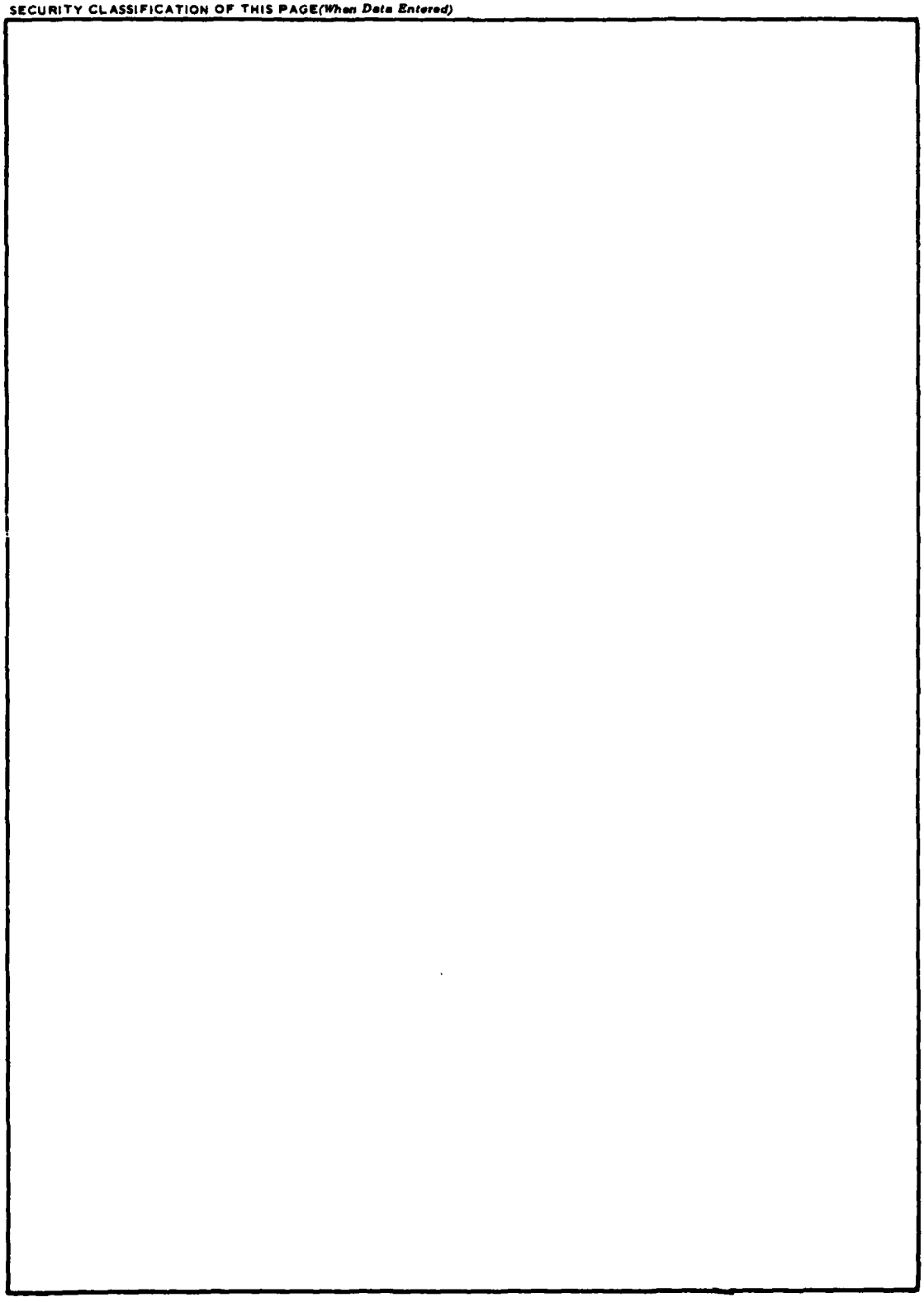

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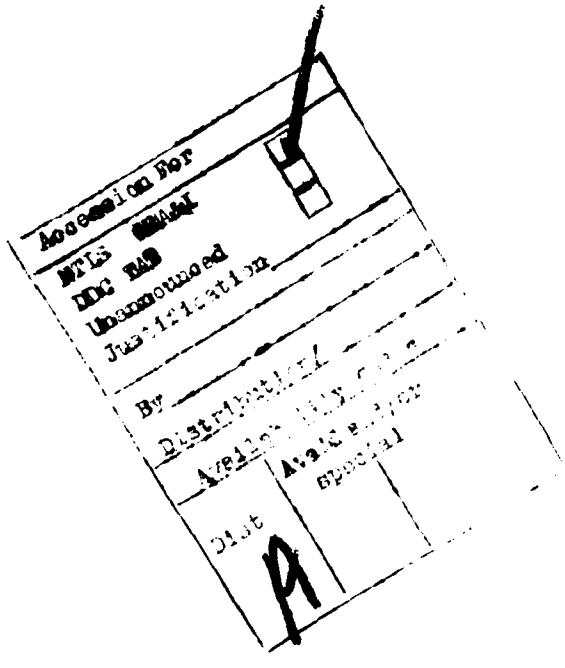

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AIR FORCE ENLISTED PERSONNEL RETENTION-ACCESSION MODEL

I. INTRODUCTION

In this period of an all volunteer armed force (AVF), it is vital for military manpower planners to have a systematic understanding of the relations among policy variables under their control and the size, cost and effectiveness of the military force. In particular, relations among authorized force levels, military compensation schedules (including retirement options), manpower quality standards and the inventory, experience and skill mix of Air Force personnel must be understood with reliability and precision. Since the Air Force is a competitor to civilian employers, these relations depend critically on the interaction between Air Force policies and the civilian labor market.

The empirical work concentrates on explaining the accession rate by sex, race, and AFQT category. Plots of the paths of the more important variables are used to give a visual impression of the historical movements over the period of the data. This type of presentation illustrates, at times in a very striking way, the impact of certain institutional changes. While the actual estimation is done for all sex, race, and AFQT categories, the analysis concentrates on the male, AFQT I through III categories. First, this group makes up between 60 and 70 percent of the enlisted force. Second, the other groups have been demand constrained over much of the period in question.

The final portion of the report concentrates on two theoretical extensions. First, the theory presented in sections II and III is extended so that individual skill groups can be analyzed. This work demonstrates that handling the enlisted force by skill group is a manageable task. Second, the dynamics of the force level adjustment to changes in certain variables is derived. Significantly, this work raises real questions concerning the interpretation of short-falls in recruiting as signals of long-run problems.

II. A LIFE-CYCLE MODEL OF THE ENLISTMENT DECISION

The theory of the enlistment decision which has been used in work on military manpower supply does not explain the life-cycle of work of the typical enlistee (Fisher, 1969). The standard theory posits that enlistments are career decisions which are based on the value today of the discounted future earnings in the military or civilian sector. An enlistee is an individual for whom the present value of military earnings, adjusted for all relevant non-monetary perquisites, exceeds the present value of civilian earnings. Once the individual enlists, the enlistee remains in the military unless some unanticipated change occurs which lowers the present value of military earnings relative to the present value of civilian earnings. If the enlistee were to fail to be promoted as rapidly as expected or if the alternative civilian wage were to rise above its expected level, the individual would exit the military for civilian employment. In other words, those who do not serve until retirement have to be considered to be individuals who misjudged or incorrectly forecast their military or civilian earnings.

Surely some errors in forecasting do account for the loss of personnel from military service, but it is difficult to accept that these errors can account for the fact that the mean length of stay in the Air Force was less than 6 years in 1976 (De Vany, Saving, and Shughart, 1978, p. 6). A far more satisfactory explanation of the enlistment decision would be to view it as consisting of the decision to enlist and the planned duration of enlistment given that the individual decides to enlist. These decisions are not independent; for example, an individual whose planned duration of service is zero is also someone who decides not to enlist. On the other hand, someone whose desired duration of service is 3 years may not enlist if the minimum tour of duty is 4 years. By considering the planned duration of the enlistment period, it is possible to analyze the effects of a minimum enlistment period. More fundamentally, a theory of the planned duration of enlistment generalizes the conventional career choice model by allowing the enlistment period to be anything from zero to 20 or 30 years.

Once it is recognized that individuals plan the duration of their enlistment then it becomes clear that the fundamental objects of choice are life-cycle work profiles. These profiles describe the work experience of an individual from the time of leaving high school through to retirement from active work, be it military or civilian. One such profile might be 4 years of military service followed by civilian work for the remainder of the work life. Another might be 20 years of military service followed by civilian work for the remainder of the work life. If these profiles are the objects of choice, then they must be ranked on the basis of the utility which they yield. In addition, the present value of earnings of each of the possible profiles must be considered since they

form the constraints on the choices that are made to achieve highest utility.

If tastes for civilian versus military work did not enter into the enlistment decision and if relative prices were equal in both occupations, e.g., the price of world travel is the same to both, then the enlistment decision could be made solely on the basis of the present value of earnings from alternative career profiles. The average enlistment period could be predicted simply by calculating the present value of earnings for alternate life-cycles of work. In this case, a fundamental factor determining the planned military work period would be the value of military experience in civilian work and in military work. If military experience raises the civilian wages that can be earned later by more than it raises the military wages that can be earned later, then it might pay an individual to enlist for a period of time sufficient to acquire that experience and then move on to a civilian job which rewards that experience more than a military job does. If the enlistment is to be worthwhile, the value of the military experience in the civilian sector must be greater than the value of the civilian experience the individual could have acquired in the same period of time.

Wealth Maximizing Life-Cycles

The first problem is to consider the possible work life-cycles and to see how they enter into the choice of cycles of military and civilian work. Though ultimately, these life-cycles are chosen on the basis of utility yielded, they can be approximated by a theory of the wealth maximizing life-cycle of military and civilian work. Consider the following simple case of a high school graduate entering the labor force. Such an individual can consider two distinct life-cycles. First, entry level civilian employment and subsequent on-the-job or formal vocational training. The earnings profile of such an individual first rises as training and experience are acquired. Then the rate of increase in wages levels off and eventually earnings fall.

Second, the entry level employment may be a military tour of duty. In this case the training and on-the-job experience will be provided at costs to the trainee that may be lower than the civilian counterpart. Subsequent to the completion of training the individual earns less than the appropriate civilian counterpart. That is, the military can recapture the training costs by paying less than the appropriate civilian wage until the first tour of duty is completed. At this time retention will require pay competitive with the appropriate civilian competition.

The principal determinants of the enlistment decision can be captured by regarding individuals as comparing the

present values of the alternate life-cycles of work. There are essentially four patterns that are of primary interest: Path One is a military career, Path Two is a civilian career, Path Three is a one-term enlistment followed by a civilian career, Path Four is a two-term enlistment followed by a civilian career. The choice of a path determines both the decision to enlist and the planned duration of service.

The available paths determine the constraints on the individual's choices. Tastes or utility must also enter the decision so that, ultimately, the choice of paths is made to maximize utility. This choice is considered in the following section, but it is useful to call attention to the factors that influence the present values of the various paths. The results of this study will show the following:

1. The enlistment decision depends on the entire earnings paths, not just the ratio of starting military to civilian wages.

2. Higher civilian wages in the posttraining period can induce an increase in the supply of first-term enlistments. Reenlistments among those presently in the force will fall, and first-termers will plan a shorter tour of duty. Thus, a high ratio of posttraining civilian to military wages will induce a high turnover regime, with a large flow of short-term enlistees on the supply side, and a high replacement demand on the part of the service. In the next section, it is shown that this problem complicates the task of estimating the elasticity of supply of personnel to the military.

3. A rise in the sum of post-military-retirement civilian earnings and military retirement benefits relative to civilian earnings with no military experience will lengthen the planned enlistment period, thus improving military retention.

4. A long second-term minimum enlistment period selects for individuals whose optimal decision is to be "locked in." If the second term is long, then the decision to go ahead with a second term is based largely on the fact that at its end, retirement benefits and civilian earnings during military retirement loom large in the present value calculation.

5. A shorter minimum first-term enlistment period would increase the supply of enlistees if all other variables remained the same. The military could not afford to train enlistees as intensively, however, since there is less time in which to recoup training costs. The net effect on supply to the military is not clear since it depends on the magnitude of these offsetting adjustments. Since

whatever comparative advantage the military may have in training derives largely from the enlistment contract, a shortening of the minimum enlistment term beyond some optimal level will eliminate its comparative advantage in competing for personnel in training-intensive fields. In fields that are not training-intensive, the military has no comparative advantage and must pay at parity with the civilian sector or make do with less qualified individuals.

The Utility Maximizing Enlistment Decision

It is naive to believe that potential recruits care only about the present value of future earnings. By the same token, it is equally naive to believe that such considerations are irrelevant. In general, given tastes and preferences concerning military employment, the greater the military-civilian present value relative to the all civilian present value, the more likely any individual is to opt for a military-civilian career plan.

One way of accounting for the tastes and preferences of potential recruits is to assume that each individual can rank "bundles" consisting of years in the military, M, years in civilian employment, C, and consumption, g. Writing this function as

$$U = U(g,M,C) \tag{1}$$

where increases in g increase utility and increases in military or civilian years decrease utility since this change means more time working and no change in consumption.

The individual is assumed to choose g, M, and C in a way that maximizes utility. But there is a constraint in that differing choices of M and C imply different earnings and therefore different consumption. The constraint can be summarized as

$$g = g(M,C,m,c) \tag{2}$$

where m, and c are respectively military and civilian wages.

The utility maximizing equilibrium can be most easily seen by a simple graphical exposition as in Figure 1. The axes are years in the military (horizontal) and years in a civilian occupation (vertical). The curves labeled I_1 through I_5 represent points of indifference between years in the military and civilian life for a given consumption. The curves nearer the origin are curves of higher utility, owing to the assumption that the relevant range of work exceeds the level where work ceases to be "fun." The wealth constraint is

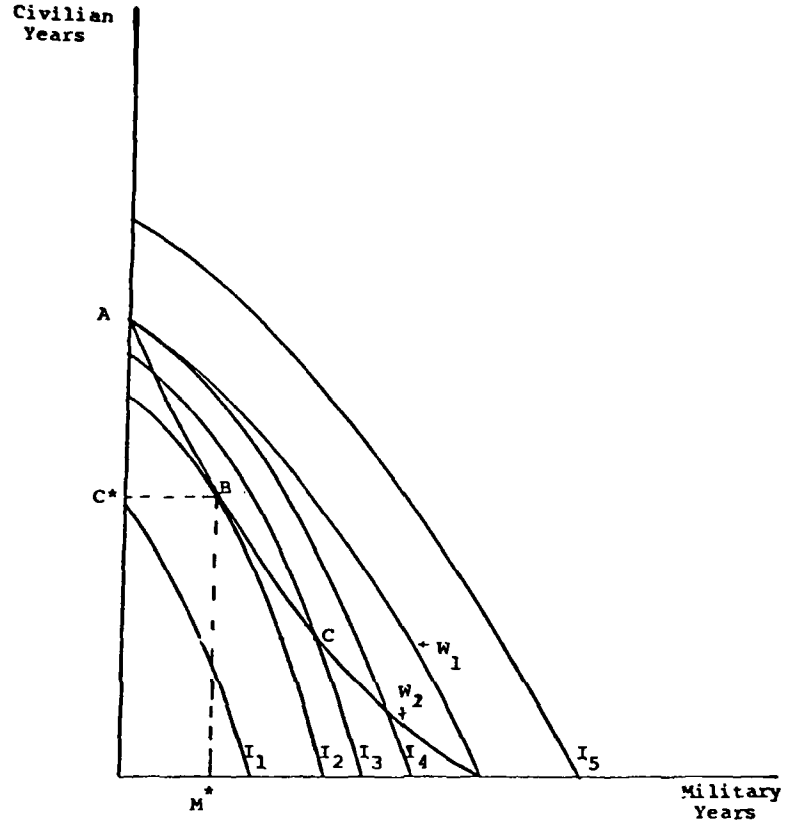

Figure 1. Optimal choice of military-civilian work cycle.

linear convex or concave from below depending upon the extent to which military training is productive in civilian work. The more productive is training, the more convex is the wealth constraint.

In the figure, the optimum point for wealth constraint W_2 is at B with M* years in the military and C* years in a civilian occupation. If the wealth constraint is W_1, then the optimum point is at A with the result that the individual specializes in a civilian career. It is now more apparent how the utility maximizing theory generalizes the usual model of the enlistment decision. Interior optima do not occur in the usual model; only choices on the axes are made, with the implcation that they are career choices. In this model, corner or interior solutions may occur with interior or mixed career choices dominating, the larger is the military's comparative advantage in training personnel (the more convex is the wealth constraint).

III. A MODEL OF THE AIR FORCE PERSONNEL MARKET

In this section the theory of enlistment supply is integrated with the Air Force demand for personnel to develop a full equilibrium model of the personnel market. Several features of the model are distinctive. The model considers both the enlistment and reenlistment markets simultaneously. The mean length of the enlistment and reenlistment periods are integrated with force level and personnel qualification considerations in a manner that determines the stock of personnel by experience and qualifications. The flows of enlistments and reenlistments that support these stocks are also determined.

There are three important special cases of the model which are studied. In the first model, the force level, experience mix and qualifications are set--by the Air Force or Congress--and then the military wage which is necessary to support these variables at their desired levels is determined. In the second model, force level, experience mix and wages are fixed and the levels of qualifications for new enlistments and reenlistments which must support these variables are determined in the labor market. In the third model, wages, qualifications are fixed by policy, and the force level and experience mix are determined by the market. Each model corresponds to more-or-less pure policies of operating in the personnel market and each raises different issues in the estimation of the supply of personnel to the Air Force. The real world Air Force personnel system probably combines aspects of all three models, but is so complex that only by studying these pure models can something be learned of its operation.

Basic Considerations

It will prove convenient to break Air Force service into two periods; period one is the first term of duty and period two is any additional time. For each of these periods the mean length of time in the military can be calculated. Let μ_1 be the mean length of stay in the first tour and μ_2 be the mean length of stay in subsequent tours. The mean length of stay in period one is less than the minimum enlistment period μ_m primarily due to first-year losses. From the theory, the mean length of stay in the two periods depends on the relative wages (military/civilian) in each period, γ_1 and γ_2, minimum quality standards Q_1 and Q_2 and the minimum enlistment period μ_m. Write

$$\mu_1 = \mu_1(\mu_m, \gamma_1, Q_1) \tag{3}$$

$$\mu_2 = \mu_2(\gamma_2) \tag{4}$$

The supply of new accessions, e_1^s, and second-term accessions (retention) e_2^s, depends on the same factors so that

$$e_1^s = e_1^s(\gamma_1, \gamma_2, Q_1) \tag{5}$$

$$e_2^s = e_2^s(Q_1, Q_2, \gamma_2) \tag{6}$$

From the theory in Section II, it can be shown under general conditions that increases in the first-term relative wage increase the mean length of stay for first termers and increase the number of new accessions desiring to enlist. Increases in the second-term relative wage increase the mean length of reenlistment and increase the supply of both first-term potential recruits and reenlistments. Increases in first-term minimum qualifications increase the mean length of stay of first termers by reducing first year losses, reduce the supply of potential recruits and increase the supply of reenlistments. Finally, increases in second-term minimum qualifications decrease the supply of reenlistments.

Force Level and Experience Mix

Let the total force level be given and equal to

$$F_1 + F_2 = F \tag{7}$$

where F_1 and F_2 are, respectively, the mean personnel inventories in first and second enlistments. The distribution of the total force in first and second enlistments constitutes the average experience level of the force; in fact, the mean enlistment period is

$$\mu = \frac{1}{F}\left[F_1\mu_1 + F_2(\mu_m + \mu_2)\right] \tag{8}$$

So, the personnel ratios F_1/F and F_2/F, as well as the mean first-enlistment period and the mean second-enlistment period, influence the average experience of the force.

Assume F and F_2/F are given for the moment--they could be set by Congress, F as a total force level requirement and F_2/F as a limit on higher level personnel (the top six ratio for example). For a given F_1 and μ_1, the flow of enlistees necessary is

$$e_1^d = F_1/\mu_1 = \ell_1$$

where ℓ_1 is the rate of departures from the first-term enlistment pool. Moreover, if the inventory F_1 is not to grow or shrink the flow of first-term enlistees completing their term must be equal to the flow of enlistees taken in. This is the bathtub

theorem which states that the flows into and out of the tub must be equal if the water is to remain at a constant level. That is, first term demand must equal first term supply.

Figure 2 depicts the first term market. In the figure, it is assumed that the military pay package is summarized by the weighted sum of first term relative wages and second term relative wages ($\gamma_1+\alpha\gamma_2$). The demand function is negatively sloped by virtue of the fact that an increase in the relative wage of the Air Force increases the mean length of stay thereby reducing turnover. Initial equilibrium is at A in the figure, i.e., where the initial demand curve D_1 intersects the initial supply curve S_1. If higher standards are imposed, then supply shifts upward to S_1^1 while demand shifts downward to D_1^1. But the downward shift in demand due to a lower rate of first term losses will not offset the upward shift in supply and the new equilibrium point B occurs at higher military relative to civilian wages.

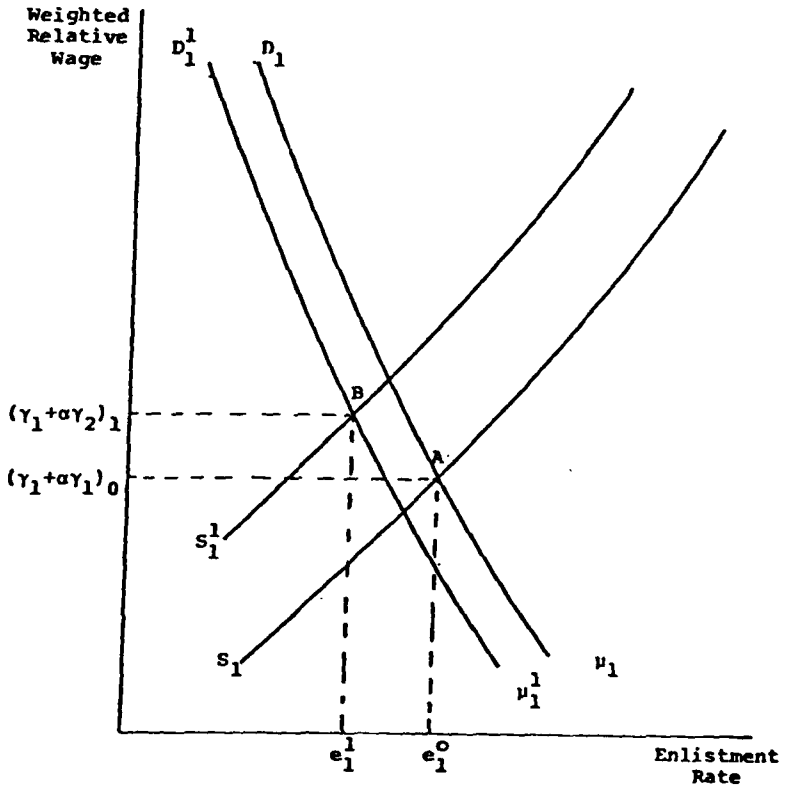

Figure 2. Equilibrium in the first term market.

In the second term market each position turns over every μ_2 years and, hence, the proportion of positions vacated each year is $1/\mu_2$. The losses from the second term personnel inventory are

$$\ell_2 = F_2/\mu_2 \tag{9}$$

and must be filled each year to maintain F_2. Second term enlistment demand is then

$$e_2^d = F_2/\mu_2(\gamma_2) \tag{10}$$

and is larger the larger the force level, F_2, and the shorter is the second enlistment period, μ_2.

The second term market equilibrium is shown in Figure 3. The second term pay ratio which equilibrates the market is indicated at point A by the intersection of supply and demand. The demand for second enlistments is a downward sloping curve reflecting the fact that, at a higher pay ratio, the mean enlistment period is longer and, therefore, a smaller flow of enlistments will maintain the personnel inventory at F_2.

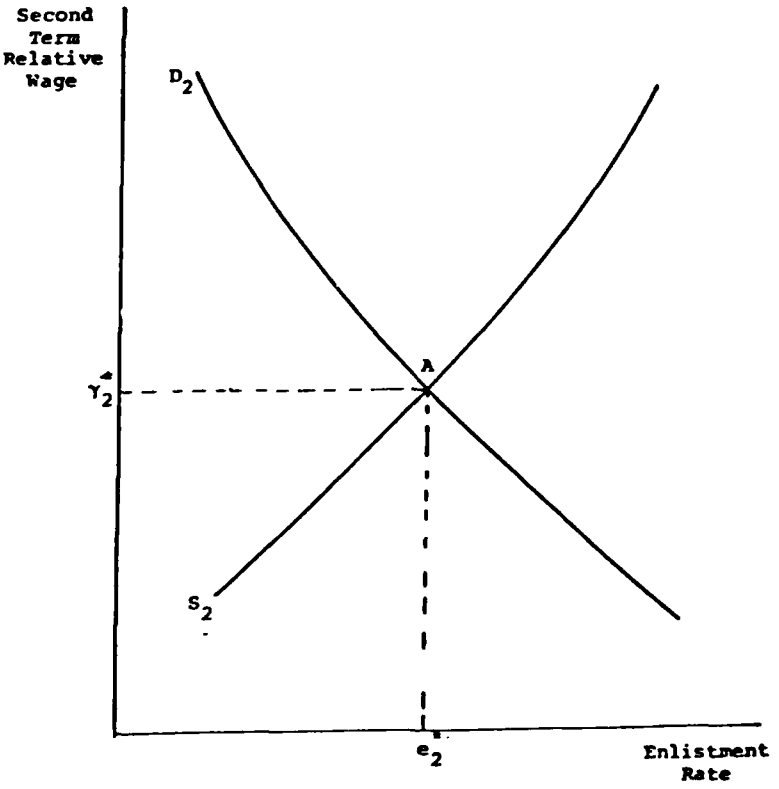

Figure 3. Equilibrium in the second term market.

This model is an important special case which describes wage-taking behavior on the part of the Air Force. It is appropriately called wage-taking behavior since force level and qualifications are set and whatever wages are necessary to achieve those ends are paid; thus the Air Force takes the equilibrating wages required in the market. If wages are fixed, then either the force level or quality must adjust to bring the demand and supply into equilibrium.

Assuming that both relative wages and force levels are fixed, the quality of the force becomes the equilibrating variable. Figure 4 illustrates this case. At the fixed wages γ_1 and γ_2 and given the predetermined force levels F_1, F_2, and minimum first enlistment period μ_1^m, the equilibrium qualifications in both markets result in Q_1 and Q_2 as minimum quality.

Now suppose the enlistment wage ratio γ_1 is raised to γ_1^1. With no change in force levels, required enlistments fall because of the decrease in first year losses. Also, higher minimum qualifications apply to enlistments. In the reenlistment market, the higher enlistment standard raises the proportion of reenlistment applicants who qualify. In addition, the number of enlistees completing tours rises. With no change in the reenlistment application rate, the supply curve shifts to the right, and the new supply curve which goes through the original point now corresponds to higher reenlistment standards. The effect of raising γ_1 raises the standards applied in both markets.

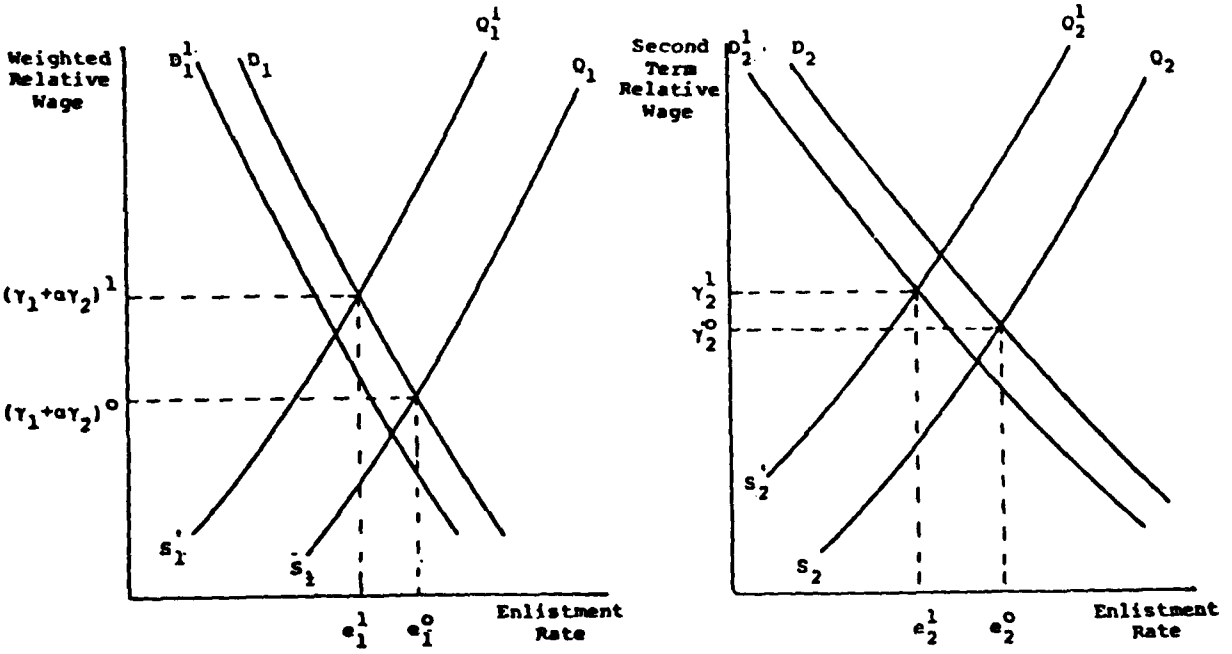

Figure 4. Wage changes and quality of the force.

If γ_2^o is increased to γ_2^1, standards rise in both markets, but by more in the reenlistment market because the increase in the mean reenlistment period reduces the quantity of reenlistments demanded, allowing a higher standard to be applied. If the level of civilian wages rises, these effects are reversed. If the post-military-experience civilian wage rises, then qualifications of enlistees rise and qualifications of reenlistees fall. Increasing the force levels F_1 and F_2 lowers qualifications.

Events in this model reveal little information about the supply of labor to the Air Force. An increase in force level with constant wages simply moves demand to the right intersecting supply curves with lower qualifications. The behavior of acceptance rates can be predicted, but since there is no wage variation, no information on supply is revealed. What is revealed is the distribution of qualifications in the enlistee pool, and this would seem to hold true only for small changes in the force level. Large changes in the force level are associated with qualitative changes in the Air Force which will affect the underlying supply, e.g., a higher percentage of the population volunteers to enlist during wartime.

Conclusions

The analysis presented above makes it clear that the accession market and the retention market are intertwined. There is a significant amount of feedback in both directions. Obviously, the number of accessions influences the gross number of first termers available for reenlistment. Less obvious is the impact of Air Force pay scales for second term individuals on the rate of new accessions. The effect of the Air Force's desired experience composition of the enlisted force also impacts on both the retention and accession markets in a non-trivial way.

All of these feedback effects make the estimation of the simple supply relations difficult. Care must be taken to ensure that observed accessions in a specific category are not the result of demand constraints. What must be accomplished is the isolation of wage effects from changes in quality, force level and retention. The next two sections present the data underlying this study and the subsequent empirical analysis. Both of these sections will present in some detail the means used to identify pure supply effects so that estimates of the effects of wage changes can be isolated from other effects.

IV. HISTORICAL OVERVIEW OF INSTITUTIONAL CHANGES AND ACCESSIONS, 1956-1977

During the time period under consideration, 1956 through 1977, considerable changes took place that were likely to impact on the enlisted accession decision. The purpose of this section is to provide a general description of the changes in institutional structure and the changes in exogenous conditions which took place during this period. In addition, the pattern of Air Force accessions during this period will also be characterized in terms of broad sex, race, and quality classes.

Institutional Changes

A number of changes took place during 1971 and 1972 which relfect the changeover to an all-volunteer force (AVF). With the absence of a draft and draft-motivated volunteers, the military services were forced into direct competition with the civilian sector for high quality recruits. In addition to a major change in the relative military compensation for first term enlistees (described below), all of the services also changed the institutional structure governing the initial enlistment decision.

The Recruiting Process

During the pre-AVF, draft dependent environment, a high quality supply of accessions could be maintained without making many commitments to the specific interests of the prospective recruits. A prospective Air Force recruit would be guaranteed assignment to one of four very general areas; mechanical, administrative, general, or electronics. This assignment was based on the Air Force priorities at this time and the recruit's aptitudes and preferences. Since the recruiting commitments were generally very broad, these commitments presented few constraints in the Air Force assignment objective and left considerable uncertainty as to where the prospective recruit would eventually be assigned.

With the advent of the AVF, the Air Force began to offer a Guaranteed Training Enlistment Program (GTEP) under which a potential enlistee is guaranteed training and assignment in some specific job specialty. Under this system, a prospective accession first meets with the recruiter and, if necessary, is given a screening test. If the recruiter feels that the individual is minimally qualified in all areas and has a good chance of meeting the minimum standards on the entrance test, the recruit is scheduled to take the Armed Services Vocational Aptitude Battery. If the prospective accession is qualified, an attempt is made to get the individual to an Armed Forces Entrance and Examining Station (AFEES) site within 15 days to take a physical exam and meet with a "booker." The booker will then work with the prospective accession and attempt to determine the individual's preferences so that a

match can be made for a particular entry date and, for about 50 to 60 percent of the accessions, a particular job.

The match for jobs versus preferences is made against a bank of jobs up to 6-9 months (effectively) in advance. Some jobs for each month's starting date are opened up each month. Once a job date is open, it is first come, first serve for all of those people who meet the minimum requirement for the given job and request the job or have a preference-skill indicator for the job. Most, about 90 percent or more, of the prospective accessions who, at this time, commit to enter at a later date will also sign up in the inactive reserves at this time to establish a paydate.

The impact of the new system on the supply of new accessions works in several ways. First, the reduction in the uncertainty associated with the training and assignment phases should increase the supply of accessions. However, to the extent that the desirable training and assignments are committed far in advance, it may decrease the willingness of a prospective recruit to sign up under one of the four general aptitude areas.

In addition to the effect of the new system on the numbers of new recruits, there could also be an effect on the quality of the accessions. Prior to 1972, the design of the accession structure was quite well suited to enabling the Air Force to select the highest quality people from among those showing up at the recruiter's office.

Under the new system, recruits are accepted during a current month to come in up to as long as 6 to 9 months later. If, at this later time, higher quality accessions become available, it might not be possible to bring them all in at that time due to a shortage of current openings. Assuming that higher quality people have a higher opportunity cost of waiting than lower quality people do, the inability to currently move as many of the highest quality people to the front of the enlistment and training queues may result in fewer high quality accessions. The net effect is an empirical question which will be examined in Section V.

Associated with the change in the recruiting and assignment system has also been an increased emphasis by all branches of the military on improving the performance of the recruiting branches. Between FY 1961 and FY 1969, total DOD recruiting expenditures increased from 68 to 125 million dollars and the total number of recruiters remained about constant even though the number of annual accessions increased greatly. (Morgan and Roseen, 1974.) In contrast, between 1970 and 1974, DOD recruiting expenditures tripled and the number of recruiters increased from 7,200 to 12,000 while the total number of accessions was declining.

The Air Force budget and number of production recruiters also increased during this period but not at as rapid a rate. During 1970, the Air Force accounted for 21 percent of the total budget and 20 percent of the total recruiters and in 1974, the Air Force accounted for 18 percent of the total budget and 16 percent of the recruiters (Morgan and Roseen, 1974). By 1977, the Air Force only had 14 percent of the total recruiters (RSMY Recruiting Service, 1978). Although the large increases in DOD expenditures should increase DOD accessions, it is not clear what the impact on the Air Force would be since the Air Force's share of this budget has fallen. To the extent that the four services compete for the same prospective recruits, the falling share will lower the supply of prospective recruits. The net effect of an increasing DOD supply and a falling percentage which decide to enlist in the Air Force is indeterminate.

Military Compensation

Probably the single most important change that occurred during this period was the change in the level and the method of adjusting military compensation. In order to summarize the major changes in military compensation that have taken place during the period 1956 to 1977, it is necessary to first define a measure for military compensation. Regular military compensation (RMC) is used as our measure for military compensation. This measure was first defined by Congress in 1965 and is taken to be the military equivalent of civilian salary. RMC consists of four elements: basic pay, basic allowance for quarters, basic allowance for subsistence and the tax advantage which accrues because neither quarters nor subsistence allowances, whether received in cash or in kind, are taxable. Excluded from this measure of compensation are special and incentive pays such as flight pay and proficiency pay and military benefits such as the use of commissary stores, retirement pay and life insurance.

Basic pay is the principal element of RMC and is the only cash element to which all members are entitled. Enlisted BAS and BAQ are cash allowances as a substitute for subsistence and quarters in kind. Basic pay increases prior to 1967 were based on separate pay increases passed by Congress. Pay increases during this period reflected the importance of conscription in supplying new recruits in that basic pay levels for enlisted personnel with less than two years of service were not increased until 1965. The basic pay increases between 1955 and 1965 were primarily designed to aid in retention of personnel once they completed their initial tour of duty.

Since 1967, annual increases have occurred in RMC and the method of determining these changes marks a radical change in military pay legislation. Beginning in 1967,

Public Law 90-207, known as the Rivers Amendment to the Federal Salary Act of 1967, tied adjustments in the general level of military compensation to the General Schedule of compensation for Federal classified employees.

The other major change in the basic pay structure occurred in 1971 when a substantial increase in basic pay for members with less than two years of service was passed. As a result, basic pay for pay grades E-1 and E-2 increased by over 85 percent. Smaller increases were also made in some pay grades for personnel with more than two years of service. The 1971 changes were made to catch up for the earlier years of excluding those with less than two years of service and to make entry pay rates more competitive in an all-volunteer force environment.

The major changes in the level and structure of the changes in military pay can be seen by examining the four alternative military pay series plotted in Figure 5 . All of the series show military wages relative to the earnings of civilian manufacturing production workers. RMWE1 uses the basic pay for an E-1 with less than two years of service for

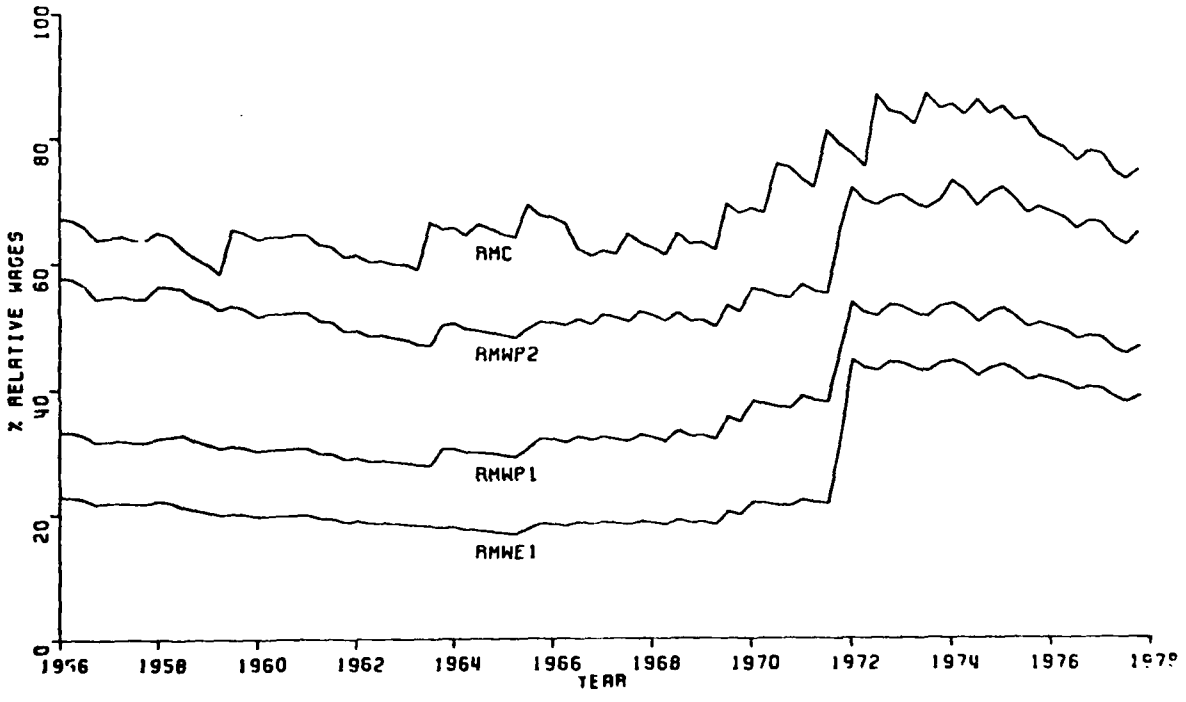

Figure 5. Relative military wages.

the military wage. RMWP1 is a weighted average of basic pay grades E-1 through E-4 where it is assumed that an accession remains an E-1 for four months, is an E-2 for eight months, an E-3 for one year, and an E-4 for the last two years. This series discounts future military and civilian earnings at 10 percent. RMWP2 is calculated by adding the cash allowances for BAS and BAQ to the RMWP1 series. RMC is the RMC series reported by the DOD and differs from the RMWP2 series in that it is weighted by the entire DOD composition of enlistment personnel in all grades. The RMC series will reflect changes in promotion rates over time as well as changes in basic pay, BAS and BAQ.

The change in basic pay levels for recruits with less than two years of service is clearly seen in Figure 5 . The level of E-1 basic pay relative to civilian pay falls consistently during the first ten years. This is followed by small increases up until 1972 where the major increase in first term basic pay took place. Since 1972, there has been a gradual decrease in this relative wage series. A comparison of RMWP1 and RMWE1 shows the changes in the structure of basic pay between the pay grades E-1 through E-4. The level of the relative pay for the RMWP1 series is about the same in 1969 as it was in 1956. The changes in pay during the early part of 1970 raised the level of basic pay and narrowed the differences across pay grades and length of service as can be seen by comparing the difference between RMWP1 and RMWE1. A comparison of RMWP1 and RMWP2 shows the importance of the allowances for quarters and subsistence as a percentage of the military wage. Although the relative importance of these items has decreased during the 1970s, these two allowances still equal about 38 percent of an E-1's basic pay in 1977. A comparison of the RMC series with RMWP2 series shows the changes in the structure of DOD enlisted personnel by pay grade and length of service. Since RMWP2 includes all of the elements of RMC for first term personnel and includes all of the changes in basic pay, BAQ, and BAS, the differences in the relative movements of the two series reflects the longer term changes in promotion rates. The relatively large decline in the RMC series during the last five years indicates that civilian wages have been increasing faster than military wages since 1972. Much of the improvement in relative military wages, as measured by RMC, which took place in 1972, had been lost by the end of 1977.

The G. I. Bill

In addition to the changes in RMC, one other major benefit was changed during the period in question. Personnel enlisting prior to the third quarter of 1966 were not entitled to any G. I. Bill benefits at the time they entered the service. The post-Korean G. I. Bill, which began in June 1966 and ended in December, 1976, did extend benefits retroactively to all

veterans who had served since January 1955, but the personnel entering during the period 1956 through 1965 did not know that they would be covered, and it is unlikely that this consideration should have affected their enlistment decision. During the period 1966 through 1976, the level of the G. I. Bill ranged from $100 per month in 1966 to $292 per month in 1976 for single veterans attending an academic institution full time. Beginning in 1977, the G. I. Bill was changed to the post-Vietnam era Veterans' Educational Assistance Program in which the Veterans' Administration will match an individual's monthly contributions of up to $75 per month on a $2 to $1 basis. A maximum of $2,700 may be contributed to this program during a member's military term.

The greater perceived value of the post-Korean G. I. Bill compared to the current program can be seen in the mean wait data which follows. Accessions with paydates during 1976 received the post-Korean G. I. Bill even though their date of enlistment was not until 1977. The mean length of wait data has a clear peak during the last quarter of 1976, which would correspond to a sequencing of the enlistment decision to obtain the G. I. Bill.

The Draft

A major concern in modeling accession behavior during this period is trying to determine the effects of the military draft. Although the Air Force inducted fewer than 50 people during any fiscal year, the presence of inductions in the other branches of the military may well have stimulated Air Force enlistments (draft-induced volunteers) by prospective draftees attempting to avoid induction into the Army or the Marines.

Although legislation enabled the induction of males into the armed services from 1956 until July 1973, draft calls had ended by January 1973, with fewer than 200 people per month being inducted after this date. During the 1956 to 1973 draft period, a major change occurred in the induction procedure beginning in January 1970, when the lottery drawing system of determining the order of induction was introduced. The introduction of the lottery, with the associated decrease in uncertainty as to who was likely to be drafted, could either increase or decrease the number of draft-induced volunteers. The empirical impact of the lottery draft system is examined in Section V.

In addition to the change in a lottery draft, a number of other changes occurred which might be expected to alter the number of draft-induced volunteers. These changes have been shown to be important in earlier studies (Cook, 1970; Fechter, 1972). First, from late 1963 until August, 1965, married men were shifted to a lower sequence of induction. This policy virtually exempted married men from the draft. The

effect of this exemption should greatly reduce the enlistment of draft-induced volunteers that are married. Since more unmarried men will be drafted the net effect of the marriage exemption on total volunteers is theoretically indeterminate and must be determined empirically. Second, the confrontation over Berlin in late 1961 was associated with a rapid increase in draft calls that would tend to temporarily increase the draft-induced volunteers to the Air Force. Third, the U.S. involvement in Southeast Asia and its associated increase in U. S. servicemen in combat roles greatly increased the costs of being inducted, since a higher proportion of draftees saw combat duty than did enlistees in the Air Force. Therefore, the impact of the large force build-up and the associated increase in inductions during this period is expected to have a larger impact on draft-induced volunteers since this is the only period during which U. S. servicemen were involved in a large combat role.

The net effect on Air Force accessions of the draft-induced enlistments should be to increase the supply of prospective recruits to the Air Force. This would allow the Air Force to enlist a greater proportion of college graduates and other higher quality people during periods with a draft. During periods of greater draft pressure, other things equal, such as during the Vietnam period, an increase in the quality of Air Force accessions should be observed.

Accession Behavior

Accession behavior will be described from several different perspectives. The total numbers of accessions will be presented first. Next, accessions are examined relative to the population base by plotting the ratio of accessions to their population base. Also included is a measure of the induction rate. Then the composition of accessions in terms of race, sex, academic education levels and AFQT categories is examined. This section concludes with some descriptive data for white male high school graduates, AFQT categories I, II, and III.

Total Accessions

The total non-prior service enlisted accessions are presented in Figure 6. The data are by quarter and are in terms of the accession's paydate. The paydate is the date that the prospective recruit signs up to enter the Air Force. The data for the last three quarters of 1965 is omitted in Figure 6 and elsewhere in the analysis because no data for an accession's academic education level is available for these three quarters.

A considerable amount of quarter-to-quarter variation is present in the total accession series. This quarterly variability reflects, to a large extent, the seasonal pattern which

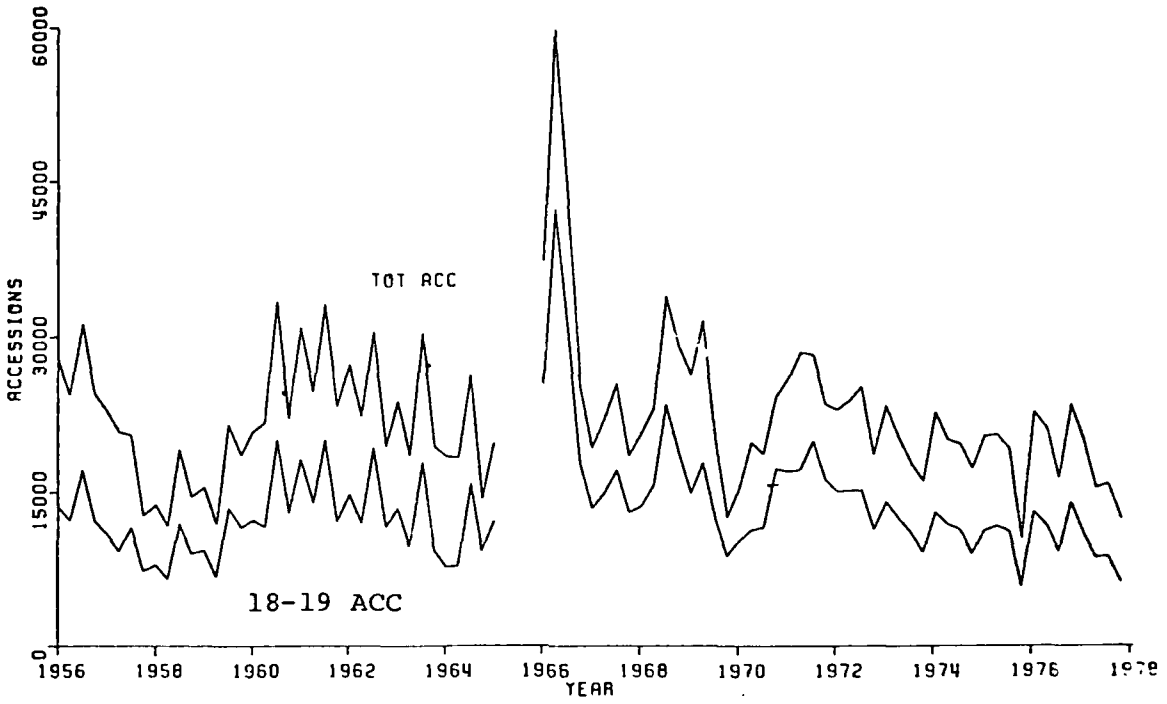

Figure 6. Total accessions and accessions 18-19 years old.

is induced by the academic school year's influence on the timing of enlistment decisions. Average quarterly accessions have decreased from about 25,000 per quarter during the early 1960's to about 18,000 per quarter by 1977.

Figure 6 also shows the number of accessions that were 18 or 19 years of age. Generally between 55 and 65 percent of the accessions are in this age bracket. The high proportion of young recruits reflects the military's policy of hiring primarily at the entry level and moving personnel up and through the ranks. The primary population base from which recruits are drawn is the 17 to 21 year old group. Within this age group, the military services are a major employer. From 1956 through the Vietnam War the combined military branches have employed between 20 and 27 percent of the 18 to 19 year old labor force and a similar percentage of the 18 to 24 year old labor force (Cooper, 1978).

Enlistment Rate and Induction Rate

During the 1956 to 1978 period, the population of 18-19 year olds more than doubled (USDHEW, 1977; USBLS, Employment and Earnings). The combined effect of a rising population base and falling accessions can be seen in Figure 7 where the enlistment rate for Air Force accessions is shown.

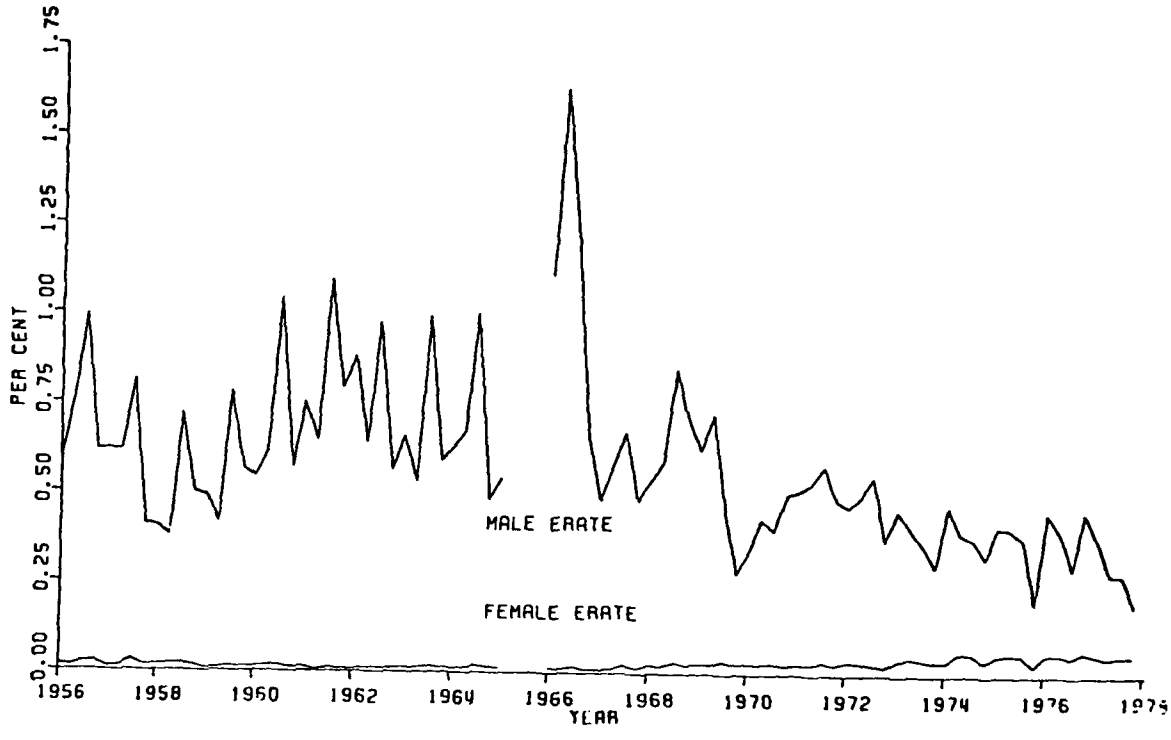

Figure 7. Male and female enlistment rates.

The enlistment rate is calculated as the ratio of accessions to the non-institutionalized civilian population of 18 to 19 year olds. What is important in Figure 7 is the significant decrease in the enlistment rate and not the absolute value of the enlistment rate. The importance of the fall in the enlistment rate is that the Air Force, together with other military branches, now only employs about one-half as large of a percentage of the relevant population base as they did prior to the beginning of the AVF period. Currently, the combined military branches employ about 10 percent of the youth labor force (Cooper, 1978).

The effect of the draft as an inducement to enlist in the Air Force will depend upon the probability that one will be inducted. This probability depends upon both the number of people inducted and the size of the population base from which they are being drawn. Figure 8 shows the ratio of the number inducted each quarter to the male population 18 to 19 years old. The impact of the Vietnam War buildup and the Berlin crisis in late 1961 are both apparent in this series. The termination of the Vietnam buildup and the rising level of military compensation had greatly reduced inductions by the beginning of the AVF, with no appreciable inductions taking place during the first half of 1973.

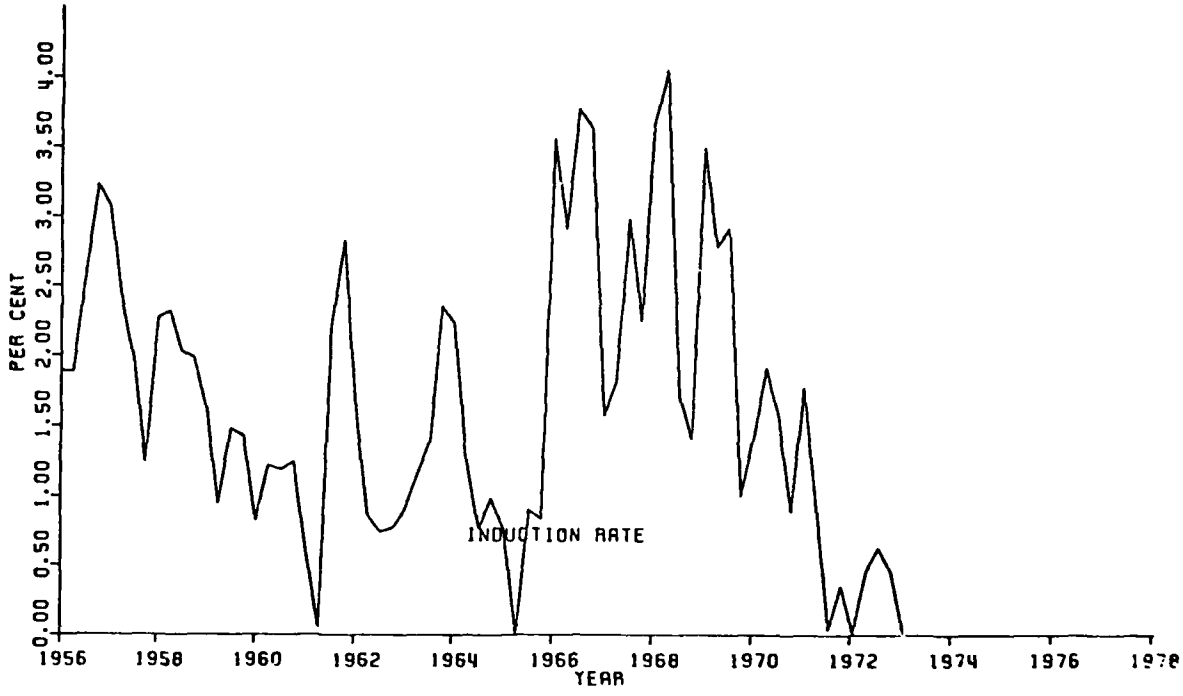

Figure 8. Induction rate.

Accession Composition by Race and Sex

Figure 9 presents the percentage composition of accessions by race and sex. Although white males still account for the majority of the accessions, the percentage of white male accessions has decreased from about 90 percent during the first ten years to about 70 percent in 1977. The primary reason for this decrease is that the percentage of females and white females in particular, has increased greatly. Prior to 1972, the participation of females was limited by law to no more than two percent of the force (Cooper, 1978). Since 1972, two things have changed which account for the increasing proportion of females. First, the restrictions on females have been removed except for the restriction that they cannot be employed in combat roles. Second, beginning in 1973, all career areas (except combat-related specialties) were opened to women. Currently, about 41 percent of women on active duty in the Air Force are serving in "non-traditional" skills (i.e., previously male-dominated skills)(Levitan and Alterman, 1977, pp. 179-181).

Accession Composition by Academic Education Level and AFQT Category

Throughout the time period under study, the Air Force has always had more prospective recruits than were demanded. The Air Force has responded to these circumstances by hiring the highest quality accessions first. That is, for a fixed wage

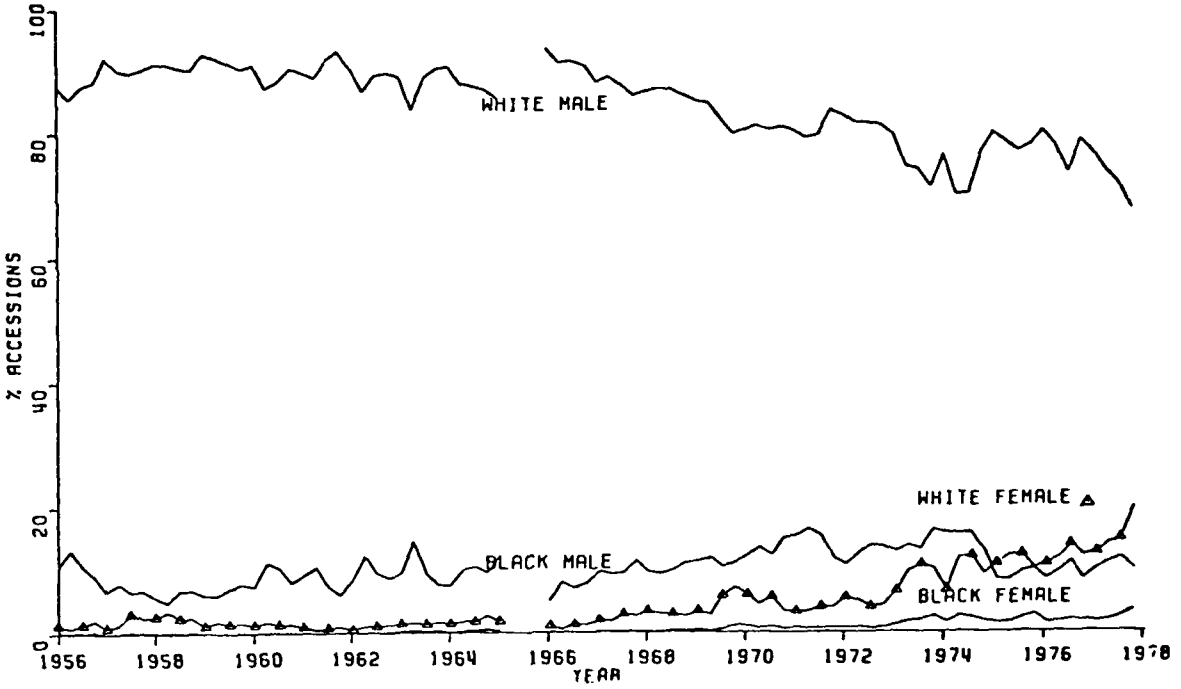

Figure 9. Accessions by race and sex (percent).

and a given supply of potential recruits, higher quality recruits are taken first with the end result being that the demand side limitations will primarily impinge on the lower quality classes of accessions. Of course, given the stochastic nature of arrivals and the existence of separate geographical quotas, this quality skimming process will not be perfect.

Quality is measured using two different dimensions; academic education level and AFQT scores. The primary criterion with respect to academic education level is whether or not the prospective recruit is a high school graduate. With respect to AFQT scores, higher scores are preferred to lower scores.

Both measures of quality are important in terms of the Air Force meeting its mission requirements at minimum cost. The aptitude score is important because the Air Force has a high proportion of schools and assignments which require individuals with higher aptitude scores. In addition, since promotions in the career force require that individuals be able to handle supervisory level responsibilities, no matter what their specific AFSC, further restrictions are placed on the minimum acceptable aptitude scores. The emphasis on high school graduates results primarily from considerations of costs. High school non-graduates have a much higher attrition rate during the first year of service which results in a loss of the training

expenses incurred up to that point. The current policy is to accept only individuals that have combined mechanical, administrative, general, and electronic aptitude scores of 170 or greater with the general aptitude score equal to 45 or greater. In addition, high school non-graduates must be in the top two AFQT categories, AFQT I or AFQT II.

Figure 10 shows the percentage of accessions from each of the categories AFQT IV and high school non-graduates. The high school non-graduate category includes G.E.D.'s. The overall trend is one of a decreasing percentage of accessions in both of these categories. Clearly the quality of accessions, measured in this way, has not decreased during the AVF period. Between 1956 and 1965, the percentage of both categories declined by 50 percent or greater. Beginning in 1967 and continuing through 1970, there is a large increase, from about 5 percent to 18 percent, in the AFQT IV category of accessions. This increase reflects the impact of Project One Hundred Thousand which stipulates that the Air Force must accept 18 percent of its recruits from AFQT mental category IV. With the termination of this program, the percentage of AFQT IV accessions declined sharply, with less than one percent of

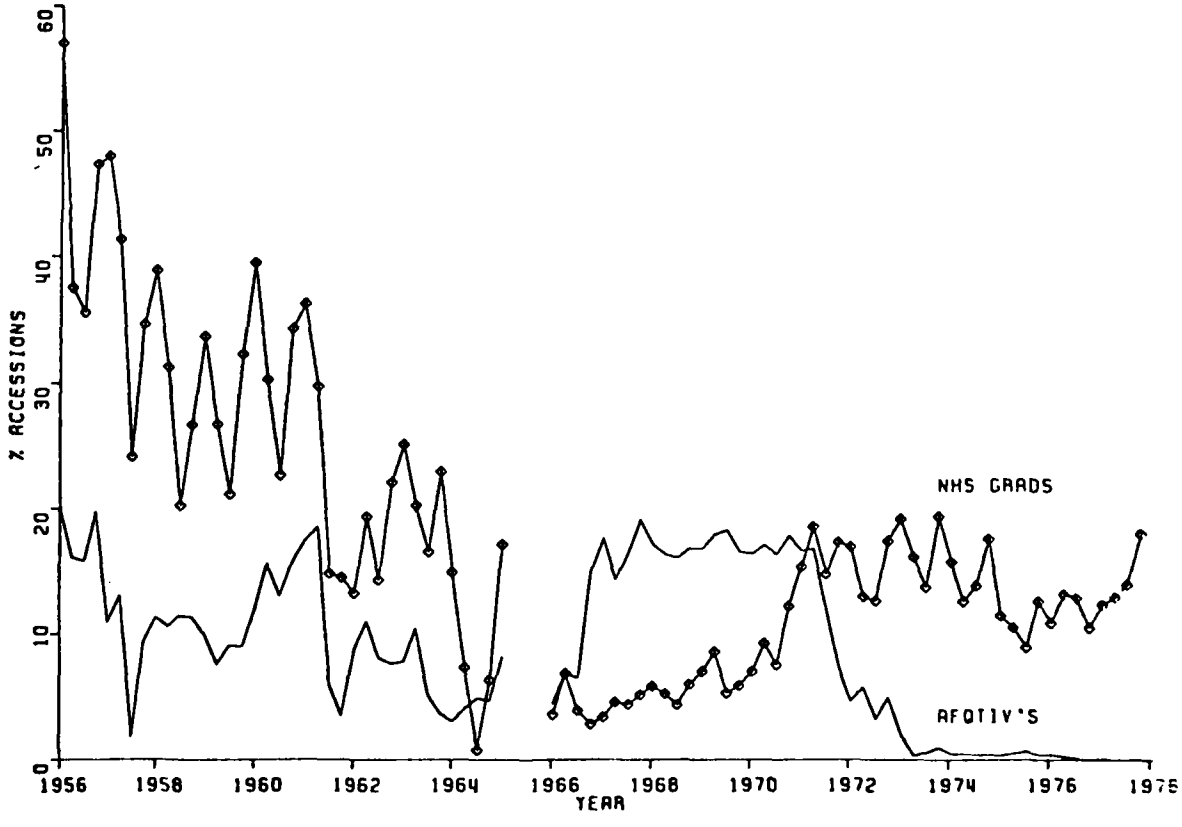

Figure 10. AFQT IV and high school non-graduate accessions (percent).

the accessions in 1977 belonging to AFQT mental category IV. The current Air Force policy of taking high school non-graduates AFQT I and AFQT II, rather than high school graduates AFQT IV, reflects the greater mix of medium to high difficulty jobs in the Air Force compared to the Army, and the current Air Force career force objectives which require cognitive skills for supervisory positions and cross-training abilities for all enlisted accessions.

The large increases in quality during the 1956 to 1977 time period are also apparent in Figure 11 where the percentage of accessions that would meet the current minimum test scores are plotted. In 1956, fewer than one-half of the accessions had combined mechanical, administrative, general, and electronic scores of 170 or greater and a general score of 45 or greater.

One further measure of quality that is examined is the percentage of accessions that received education beyond the high school level. Figure 12 shows the percentage of accessions with some college. The effect of the draft policies is apparent in Figure 12. During the period of the draft, and especially during the Vietnam War buildup, the percentage of accessions with some college increases greatly. A peak is reached in 1966 with over 30 percent of the accessions having

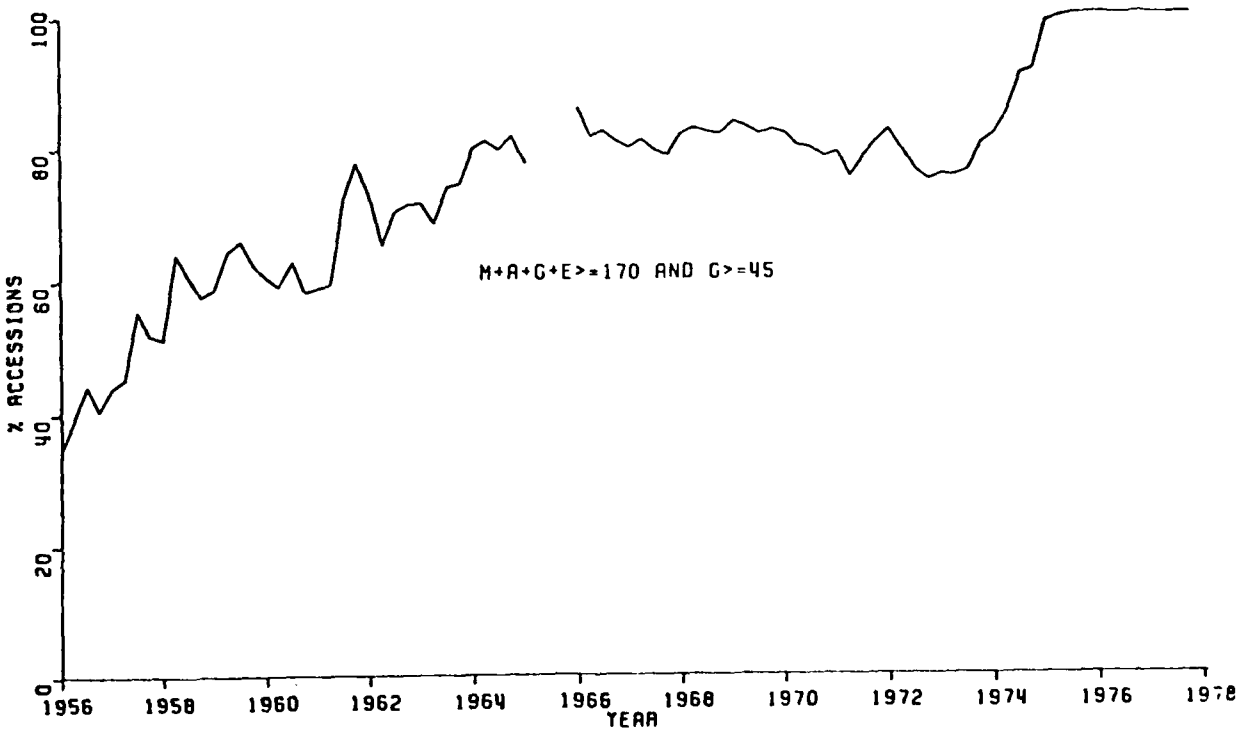

Figure 11. Accessions meeting current requirements (percent).

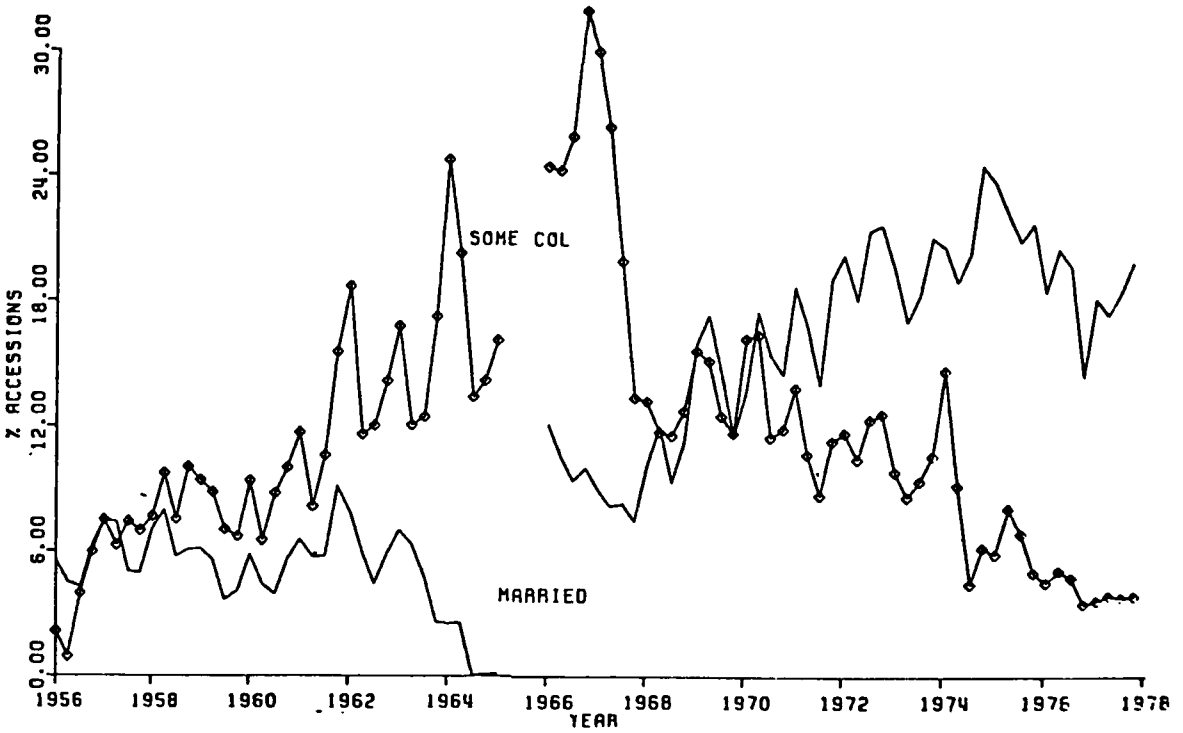

Figure 12. Accessions with college and married accessions (percent).

taken courses beyond the high school level. Even though military wages increased substantially with the advent of the AVF, the percentage of accessions with some college decreased to about 3 percent in 1977.

Figure 12 also shows the percentage of accessions that are married. Two changes in this percentage are of interest. First is the large decrease in this percentage during the period of the marriage exemption beginning in 1964. Married accessions decreased to close to zero and remained there until the end of the exemption, at which time the percentage of married accessions rose to about 12 percent. The second interesting feature is the relatively large percentage of married accessions during the AVF period. The large increase in military compensation that occurred with the ending of the draft made the Air Force a much more competitive employer for married accessions.

Descriptive Data: White, Male, High School Graduates, AFQT I-III

In some of the empirical analysis contained in Section V, we will concentrate on the white, male, high school graduates, mental categories I, II, and III. These categories have accounted for over one-half of the accessions throughout the

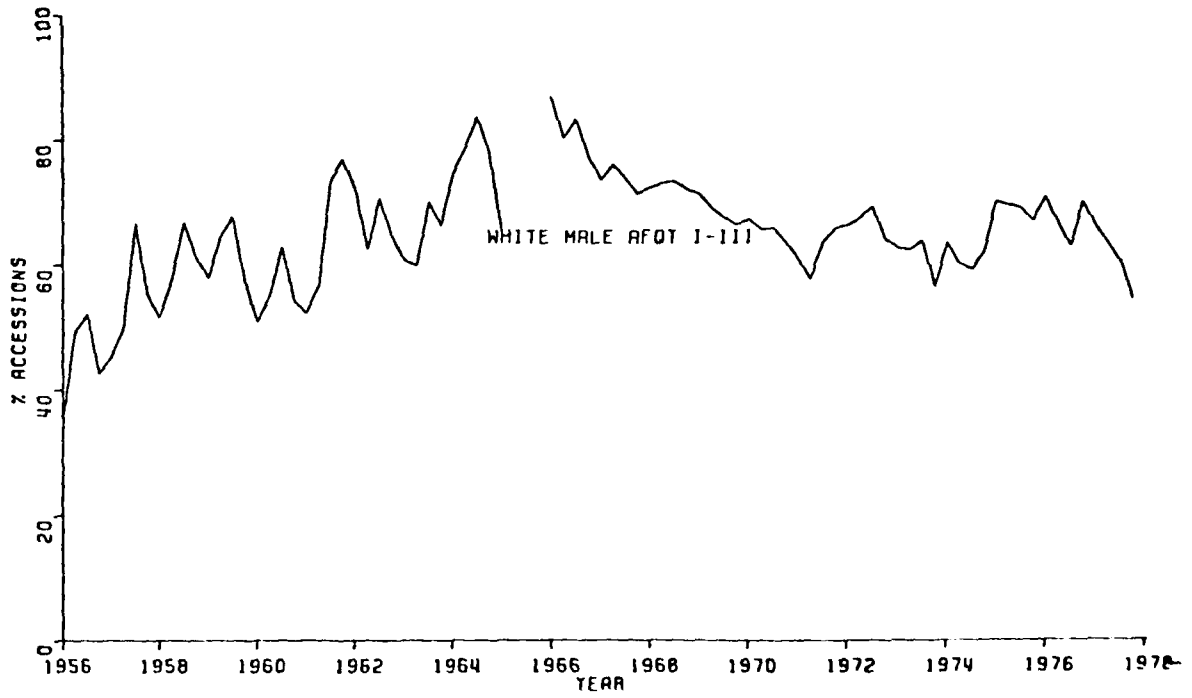

Figure 13. White Male High School Graduate AFQT I-III Accessions (Percent)

period 1956 through 1977 as is shown in Figure 13. These categories are selected for special emphasis in Section V because they constitute the largest groups where demand constraints in terms of quality skimming or force objectives are absent throughout most of the time period. The absence of demand limitations is consistent with the percentage of accessions that were not high school graduates, AFQT I, II, or III, throughout the most of the period.

One of the questions examined in Section V using these three categories is the importance of the mean length of time between the paydate and the date of enlistment (the queue) on accession supply. With this in mind, the queue data for the white, male, high school graduate, categories I through III is presented in Figure 14. Data for the paydates is not available prior to 1966 and the date of enlistment is used. Since 1966, the only instances where a significant number of paydates are blank on the data files is for the period between the second quarter of 1975 and the second quarter of 1976, where as many as 40 percent of the paydates are missing. Setting the paydate equal to the date of enlistment will introduce some errors into the accession series during these four quarters. These errors will probably not significantly affect the results of the accession supply estimates. However, since the length of wait is

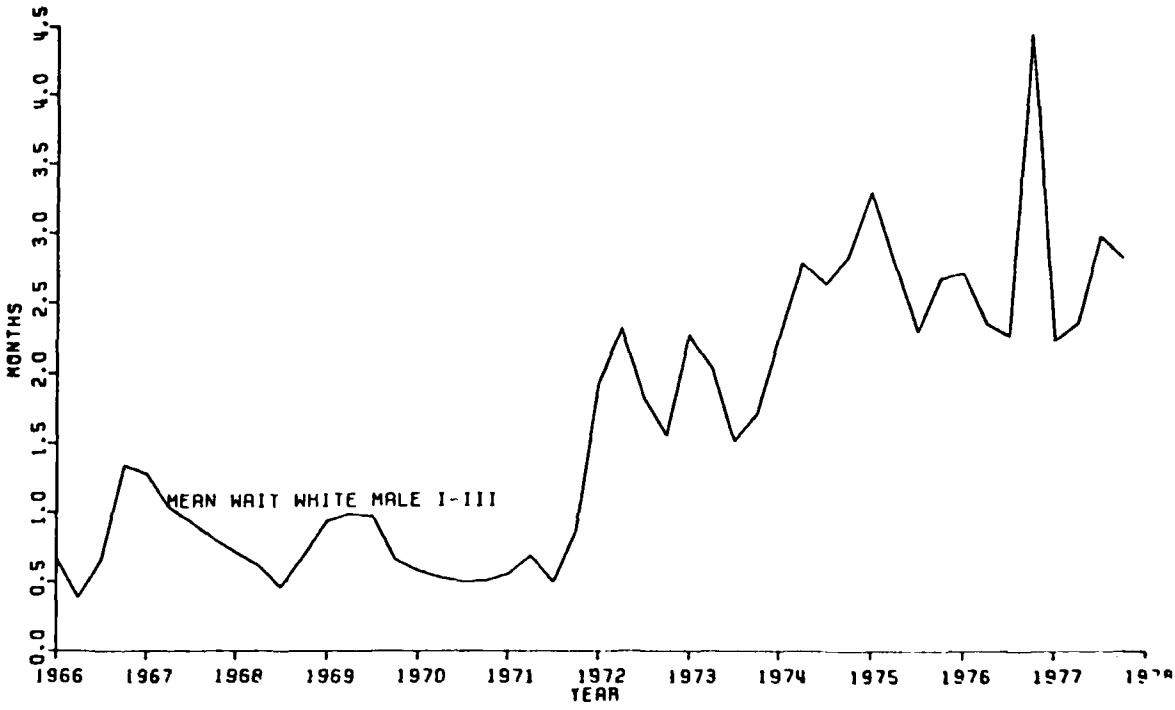

Figure 14. Mean length of wait.

measured as the difference between these two dates, the queue data for these four quarters may be subject to a substantial measurement error.

In examining Figure 14, a sharp increase in the mean length of wait is seen in 1972 where the mean wait doubles. This increase is due to the introduction of the delayed entry Guaranteed Training Enlistment Program (GTEP) discussed above. When this program was introduced, accessions could sign up to enter the Air Force 3 to 9 months in the future and receive a paydate at the time that they signed up. The advantage of signing up and receiving a paydate in advance of the actual date of enlistment is that in computing length of service for pay purposes, the paydate is used. The impact of the discontinuation of the old G. I. Bill is evident in the value of the mean length of wait at the end of 1976. A large number of accessions signed up in 1976 (and received a paydate) but did not enter the Air Force until 1977. By doing this, these accessions were entitled to receive the old G. I. Bill even though they had a 1977 date of enlistment.

V. ENLISTMENT SUPPLY

In this section, the conceptual framework used for analyzing enlistment supply behavior is presented. An econometric model is then specified and estimated. The sensitivity of the estimated wage elasticity with respect to alternative model and variable specifications is then examined. The section concludes with a summary of the major empirical results obtained.

Conceptual Framework

The observed quantity and quality of Air Force accessions reflects the interaction of individual labor supply behavior and the demand behavior of the Air Force. One way to separate the demand and supply influences on accession behavior is found by examining the way in which potential recruits are accepted into the Air Force. The Air Force selects the highest quality accessions available during a given period, subject to any external constraints it faces such as Project One Hundred Thousand or the limit on females prior to 1972. Historically, as discussed in Section IV, the Air Force has viewed accessions in the high school graduate, mental categories I-III as the highest quality accessions.

The quality selection procedure followed by the Air Force suggests that, from the demander's viewpoint, prospective recruits are not homogeneous. Rather, the Air Force demand for new personnel can be disaggregated into a hierarchy of separate demand functions ordered by quality. For a given total recruit objective, the Air Force first hires all of the highest quality recruits available. Additional recruits are then hired sequentially from the lower quality groups until the recruit objective is satisfied. The total number of accessions that are hired from the lowest quality category is determined by the interaction of the recruit objective and the number of accessions obtained from the higher quality groups. Not all of the lowest quality prospective recruits are admitted, as is indicated by the fact that the Air Force has always satisfied its recruit objective for the years 1956-1978.

The data presented in Figure 10 shows that the Air Force has generally admitted a significant number of accessions from the combined AFQT IV and non-high school graduate categories. Only during the first few years of Project One Hundred Thousand, when the Air Force was required to enlist 18 percent of its accessions from mental category IV and the percentage of high school non-graduates dropped below 5 percent, is there any indication that there might have been some demand limitations on high school graduate AFQT I-III accessions.

The assumption of quality selection, combined with the enlistment data for mental category IV and high school

non-graduates, suggests that for all practical purposes the Air Force accepted all of the male high school graduate, mental category I-III recruits that volunteered during this time period. Therefore, the observed accession data for this group of accessions can be interpreted as observations on an accession supply curve. This is not the case for mental category IV and high school non-graduates, where demand limitations are present throughout most of the period. Similarly, the constraint on females, which restricted them to two percent of the force or less during most of the time period, probably resulted in demand limitations, even among the high school graduate, AFQT I-III categories.

Model of Enlistment Supply

The model of enlistment supply used follows directly from the life-cycle model of the civilian/military work decision previously developed. In deciding whether or not to spend time in the Air Force, an individual will evaluate the returns available from spending some time in the Air Force relative to spending all of the time in a civilian occupation or in some other branch of the military. Some of the important factors governing this decision are (i) the wages and training available in the alternative occupations, (ii) the package of other benefits associated with the alternative occupations, (iii) the probability of obtaining employment in a civilian occupation and (iv) the probability of being inducted into another branch of the service and receiving the wage and training package and duty assignments that a draftee receives.

It is assumed that if the military increases its wages, training or benefits relative to the civilian sector, more individuals will elect to spend part of their working years in the military. Also, if the probability of finding a civilian job decreases, then more individuals will enlist in the military. Finally, an increase in the likelihood of being inducted into another branch of the service, which is an occupation that many individuals view as less desirable than the Air Force, is assumed to increase accessions into the Air Force.

The total number of individuals that decide to enlist in the Air Force depends on the percentage of individuals that find the current Air Force offer attractive and on the size of the population base from which the Air Force draws its recruits. In modeling the supply of accessions, it is assumed that enlistments are proportional to the population base and the dependent variable used is the enlistment rate (enlistments/population).

Econometric Model of Accession Supply

In this section an econometric model of accession supply is presented where the proportion of the eligible population enlisting (the enlistment rate) depends on those factors outlined above. The variables included in the model are selected to match those factors discussed above as closely as is possible given the available data. One further assumption is made in going to the estimating equation. It is assumed that individuals' pay decisions are based on the level of military pay relative to civilian pay. Relative military wages (RMC/civilian earnings) are used in the estimating equation. The following equation is estimated on quarterly data from the first quarter of 1956 through the last quarter of 1977:

$$\begin{aligned} LER_i = {} & \beta_o + \beta_1 \text{ LRELWRMC} + \beta_2 \text{ LUR } z_i + \beta_3 \text{ GIBILL 1} \\ & + \beta_4 \text{ LRELWGI1} + \beta_5 \text{ TRANSGI1} + \beta_6 \text{ GIBILL 2} + \beta_7 \text{DRAFT} \\ & + \beta_8 \text{ LOTTERY} + \beta_9 \text{ LDR.RATE} + \beta_{10} \text{ BERLIN} + \beta_{11} \text{ MAR,EXE} \\ & + \beta_{12} \text{ VIETNAM} + \beta_{13} \text{ LV.DEATH} + \beta_{14} \text{ QTR1} + \beta_{15} \text{ QTR2} \\ & + \beta_{16} \text{ QTR3} + \beta_{17} \text{ DV CONS} + \beta_{18} \text{ DV QTR1} + \beta_{19} \text{ DV QTR2} \\ & + \beta_{20} \text{ DV QTR3} + \varepsilon. \end{aligned}$$

A brief description of the variables is contained in Table 1. The enlistment rate is defined as the number of accessions divided by the civilian noninstitutional population aged 18-19 years for the corresponding race, sex category. Thirty-two separate constant quality cohorts are examined. The cohorts are defined by race, sex, academic education level and AFQT categories.

The first six exogenous variables measure the returns from enlisting in the Air Force relative to remaining a civilian. The first two variables are included in almost all studies of military accession. The first variable is the log of the ratio of monthly regular military compensation (RMC in Section IV) divided by the monthly earnings of production workers in manufacturing. This ratio reflects the current relative return from enlisting in the Air Force compared to civilian employment. The sign of the relative wage coefficient, β_1, should be positive since an increase in the relative military pay should result in increased accessions. The second variable is the log of the unemployment rate for 18 and 19 year-olds in the ith cohort. Separate unemployment rate series are used for white males, white females, black males and black females. Since an increase in the current unemployment rate lowers the return from remaining a civilian and should increase accessions, the coefficient of the unemployment rate, β_2, should be positive. The next four variables crudely measure the value of the G. I. Bill during this period.

Table 1. Variable definitions.

LER_i	= log of the enlistment rate for the ith accession category
LRELWRMC	= log of (regular military compensation/civilian monthly earnings)
LUR Z_i	= log of the unemployment rate for the ith accession category
GIBILL1	= dummy variable for Vietnam era G. I. Bill
LRELWGI1	= log of (G. I. Bill monthly payment/civilian monthly earnings)
TRANSGI1	= dummy variable for end of GIBILL1
GIBILL2	= dummy variable for Post-Vietnam era G. I. Bill
DRAFT	= dummy variable for the period with a draft
LOTTERY	= dummy variable for the period with a lottery
LDR.RATE	= log of (the number of inductions/18 & 19 year old male population)
BERLIN	= dummy variable for the period of the Berlin crisis
MAR.EXE	= dummy variable for the marriage exemption from the draft
VIETNAM	= dummy variable for the period of the Vietnam War
LV.DEATH	= log of (the number of deaths in Vietnam/18 & 19 year old population)
QTR1	= seasonal factor, first quarter 1956-1971
QTR2	= seasonal factor, second quarter 1956-1971
QTR3	= seasonal factor, third quarter 1956-1971
DV CONS	= seasonal factor, fourth quarter 1972-1977
DV QTR1	= seasonal factor first quarter 1972-1977
DV QTR2	= seasonal factor second quarter 1972-1977
DV QTR3	= seasonal factor third quarter 1972-1977

GIBILL 1 assumes a value of one during the Vietnam era G. I. Bill and GIBILL 2 assumes a value of one during the post-Vietnam era G. I. Bill. LRELWGI1 is a measure of the magnitude of the payments received under the Vietnam era G. I. Bill and is measured as the log of the G. I. Bill payment divided by the civilian wage. Since larger payments would increase the returns from being in the Air Force, the coefficient of LRELWGI1, β_4, should be positive. The remaining variable, TRANSGI1, is included to account for the shifting of paydates from 1977 back to 1976 so as to qualify for the non-contributory G. I. Bill even though the date of enlistment occurred in 1977.

The next seven variables are included in an attempt to model the effect of the draft and other draft-related variables. All of these variables have been included in other studies of military accessions during comparable time periods. DRAFT is a dummy variable which takes on the value one

from 1/56 to 4/72, the period during which inductions were being made. Similarly, LOTTERY assumes a value of one during the period of the lottery draft. The induction rate LDR.RATE is measured as the log of inductions divided by the 18 and 19 year old male population. BERLIN and MAR.EXE are dummy variables for the rapid buildup in Berlin in 3/61 to 1/62 and for the existence of the virtual deferment of married people from 3/63 to 2/65. The remaining two draft related variables are for the U. S. involvement in Southeast Asia. VIETNAM is a dummy variable that corresponds to the involvement in Vietnam and goes from 3/65 to 4/72. LV.DEATH is the log of the number of deaths in Vietnam relative to the 18-19 year old population.

During any given time period, the total effect of the relevant draft variables should be positive in that the number of draft-induced volunteers should be positive. In addition, the coefficient for BERLIN, β_{10}, should also be positive since more draft-induced volunteers are anticipated during the Berlin build up. The coefficient on LDR.RATE, β_9, should also be positive since larger induction calls should produce more draft-induced volunteers. As discussed in Section IV, the sign of the coefficients on MAR.EXE, β_{11}, and on LOTTERY, β_8, are theoretically indeterminate.

The remaining variables are seasonal dummies. Two sets of seasonal dummies are required due to the introduction of the delayed entry GTEP program in 1972. As was shown in Section IV, the mean wait increased by about 1 month at this point. This increase in the mean wait will shift the seasonal pattern of paydate accessions back 1 month. The net effect of the last four seasonal dummies can be used to evaluate the overall effectiveness of the new recruiting structure. If the net effect has a positive sign, this would indicate that, other things constant, the new recruiting system results in more accessions than the old method of recruiting.

Empirical Results

The empirical results are presented in the following order. First, the accession supply equation is estimated for each of the 32 accession cohorts using ordinary least squares, (OLS). The results of these regressions are then evaluated in terms of the Durbin-Watson test for autoregression, the proportion of the variation explained by the regression (R-squared) and the range of values for the point estimates of the wage elasticities. Then the sensitivity of the point estimates of the wage elasticities is examined with respect to using alternative functional forms of the regression equation. This is followed by an examination of the coefficients of the other variables in the accession supply equation. Alternative wages and time periods are then examined. Next the question of whether the length of the queue is empirically important

in estimating the wage elasticities is examined using a two-stage method of estimation over that time period for which queue data is available. In order to obtain more precise estimates of the wage elasticity, regressions are then estimated using across equation tests of the equality of supply elasticities.

Durbin-Watson and R-squared

An examination of the Durbin-Watson test statistics for male, high school graduate, AFQT I-III categories provides no evidence that the hypothesis of no autoregression should be rejected. Also, the male high school graduate categories have regression F-statistics that are significant at the one percent level with values of R-squared between 0.61 to 0.89. In five of the 32 regressions, the regression F-statistic is not significant at the one percent level. All of these cases are for categories of accessions where there is likely to have been demand limitations during this time period. Four of the insignificant F-statistics are for AFQT IV categories and one is for a non-high school graduate category. Similarly, those cases where the value of the Durbin-Watson test statistic indicates the presence of autoregression are confined to the non-high school graduate category. Overall, the results for the accession cohorts where demand constraints are likely to be unimportant are quite good.

Estimated Wage Elasticities

Table 2 presents the estimated wage elasticities, together with their standard errors, for the 32 accession cohorts. Using a similar empirical approach, earlier accession studies have reported wage elasticities of between 0.46 and 2.78 over sub-periods of the sample used here (Fechter, 1972; Cook, 1970). An examination of the point estimates for male, high school graduates, AFQT I-III in Table 2 shows that, with the exception of the AFQT I category for white males, the point estimates all lie within this range. The lower AFQT categories appear to have a greater elasticity than the higher AFQT categories, a proposition that will be examined in greater detail below.

Another interesting feature of the estimates in Table 2 is the implausible range of values obtained for most of the AFQT IV and high school non-graduate categories. These results are consistent with the evidence presented earlier showing the impact of demand factors on these categories.

Alternative Functional Forms

Previous studies of military accession supply have used a number of alternative functional forms (Fechter, 1972; Cook, 1970; Grissmer, 1978; and Cooper, 1977). In addition to the constant elasticity functional form used above, four

Table 2. Wage elasticities OLS constant elasticity[1].

	AFQT I	AFQT II	AFQT III	AFQT IV
White Male H.S.	-0.1669	0.5359	1.7554	0.9970
	(0.8424)	(0.6959)	(0.7543)	(1.5736)
Black Male H.S.	0.9317	1.5345	1.9866	-1.0159
	(1.6399)	(0.9318)	(0.9631)	(2.1296)
White Female H.S.	2.5061	0.1759	1.3065	11.7168
	(2.1590)	(0.7595)	(0.9455)	(7.8308)
Black Female H.S.	8.8209	0.3725	2.8344	4.6838
	(4.2533)	(1.8016)	(1.4990)	(8.6304)
White Male N.H.S.	5.3688	5.4593	6.2072	19.7340
	(1.7039)	(1.4748)	(1.7557)	(3.9530)
Black Male N.H.S.	4.0553	5.1248	5.2997	18.5807
	(3.0089)	(1.8055)	(1.8295)	(4.0330)
White Female N.H.S.	-1.0330	1.5586	1.2756	16.3660
	(2.9372)	(1.6156)	(1.8398)	(7.8128)
Black Female N.H.S.	-2.5481	-0.1736	2.5419	29.8430
	(5.3718)	(1.9048)	(3.4314)	(14.7035)

[1]The standard error of the coefficient is given in parenthesis.

alternative functional forms which have appeared in the literature are examined here: logistic, log-linear, linear-log, and linear. The primary question examined is the sensitivity of the point estimates of the wage elasticities to the functional form specification. For the male, high school graduates, the logistic and the log-linear specifications give elasticities that are within 0.3 of the value obtained for the constant elasticity form. With the exception of the black male AFQT I, the linear and linear-log forms also give comparable results for the male, high school graduate, AFQT I-III categories. In general, the only cases where the functional form makes a large difference in the elasticity estimates is for those categories where demand restrictions tended to make the original estimates of questionable value, e.g., the AFQT IV cohorts.

In view of the results obtained thus far, two pragmatic decisions are made with respect to the rest of the empirical analysis. First, the focus of the rest of the empirical analysis will be on the six male, high school graduate, AFQT I-III cohorts. The results obtained above are in agreement with a hypothesis that demand restrictions were present for the non-high school graduates and the AFQT IV categories. Therefore, these regression equations will, at least in part, reflect the demand side of the market in addition to labor

supply behavior. During most of the period, there probably are elements of demand restrictions also operating for most of the female cohorts. This seems to be consistent with the point estimates which give wage elasticities close to zero for the AFQT II high school graduate female cohorts.

Second, further analysis will be made using the constant elasticity functional form. The results obtained for the male, high school graduate AFQT I-III cohorts are quite robust with respect to functional form and the constant elasticity form has the convenient feature that the estimated coefficients are the elasticities.

Unemployment, G. I. Bill, and the Draft

The effects of unemployment rates on accession behavior were examined using an age-race-sex specific unemployment rate series. Separate unemployment series for white males, black males, white females, and black females, all age 18-19, were used as exogenous variables. The general pattern of unemployment elasticities obtained indicate that this variable is not an important determinant of accession behavior. These results are consistent with a general failure to obtain significant positive unemployment elasticities in military accession studies (Fechter, 1978; Grissmer, 1978). Although other studies have not used sex, race specific unemployment series, this does not seem to alter the results.

The G. I. Bill coefficients are significant at the one percent level for males AFQT I and AFQT II. In all cases, the pattern of results for the males is similar. The relative payment level had a positive effect and the transitional dummy was positive, reflecting the sequencing of pay dates to receive the G. I. Bill. However, the net effect estimated for all components of the G. I. Bill is negative rather than positive as anticipated. It is not known what is misspecified, but the conjecture is that a respecification of the combined G. I. Bill variables directly as a part of the military wage would help to isolate its actual impact on accessions.

The draft is modeled with a number of continuous and dummy variables. If the collection of draft variables is examined as a group, the draft variables are significant at the one percent level for all the male high school graduate cohorts. The effect of the draft on accession behavior was estimated by calculating the mean fraction of people within a cohort that were draft induced. Three different time periods are examined. The time periods are selected to measure the effect of the draft without the Vietnam War (1-1956 to 1-1965) and to measure the effect of the draft during the Vietnam War without a lottery draft (1-1966 to 4-1969) and with a lottery draft (1-1970 to 4-1972).

Under all three draft periods, a greater percentage of AFQT I white males are draft induced than the percentage for AFQT II or AFQT III. Also, a reduction of 20 to 40 percent is detected in the percentage of white males that are draft induced with the introduction of the lottery draft system. The actual percentage of draft-induced volunteers is as great as 70 percent for the AFQT I cohort and is always 20 percent less within a given time period for the AFQT II and AFQT III cohort categories. This stronger response for the AFQT I cohort is consistent with the large increase in college graduates in this cohort during the Vietnam War period. The percentage of draft-induced volunteers during the 1956 to 1965 period is similar to estimates reported elsewhere for DOD (Fechter, 1972).

As was discussed in Section IV, since the marriage exemption reduced the draft pressure for married males and increased the draft pressure for single males, the sign of the coefficient on MAR.EXE is theoretically indeterminate. The sign of this coefficient is positive for some cohorts and negative for others, with no obvious pattern in the signs. The coefficient for Berlin was positive in five cases, as predicted, with numerical values ranging from + .16 to + .52.

One further set of coefficients is worth examining. The second set of seasonal dummies will, together, allow the intercept of the regression to shift during the period that the delayed entry, Guaranteed Training Enlistment Program, is in effect. The extent of the impact of the delayed entry program can be determined by calculating the percent of a given cohort that is induced by the presence of this program. A positive impact of 40 percent, 24 percent, and 10 percent is found for the white male AFQT I, white male AFQT II, and black male AFQT I cohorts, respectively. A negligible effect is found on the other three male cohorts. The delayed entry program does help in recruiting the higher AFQT male accessions. For the females, all cohorts except for the black AFQT III cohort are positive. Here, though, the interpretation is somewhat different since the opening of the delayed entry program coincided with the opening of numerous new career occupations. It is the positive combined effect of opening a wider selection of career fields and of instituting the delayed entry program that is being measured. The magnitude of the effect is about 60 percent for the white AFQT II and AFQT III cohorts, over 1000 percent for AFQT I, and about 35 percent for the black AFQT I and AFQT II cohorts.

Alternative Wage Variables and Time Periods

The overall results obtained indicate that the accession supply behavior of male, high school graduates is specified

reasonably well. The results obtained are, in general, consistent with earlier military accession studies. Two recent studies are now compared directly with the above results by estimating the accession supply equation over comparable time periods and using a comparable military wage series. In addition to providing a direct comparison with these earlier studies, the results obtained also provide valuable information on the sensitivity of the results obtained to changes in the sample period and changes in the wage variable.

In the first study examined, A. A. Cook, Jr., studied Air Force accession behavior over the time period between the first quarter of 1959 and the second quarter of 1967 (Cook, 1970). Cook uses a measure for military wages that includes the changes in promotion rates for first-term enlistees. He calculates the present value of a 4-year enlistment assuming a promotion rate schedule that reflects the actual distribution of first-term airmen pay grades by length of service. The rest of the model is similar to the model used here.

The accession supply equation is estimated over Cook's time period using Cook's military wage, the RMC military wage and three additional military wage series. The five wage series used are: (i) (RMWC) Cook's wage series which is a present value wage for four year's service computed using only basic pay and using the changes in the promotion rates, (ii) (RMC) the wage series used above which is the RMC series where promotions are weighted across DOD and for all enlisted personnel, (iii) (RMWE 1) a wage series using E 1 basic pay only, (iv) (RMWP 1) a wage series using the present value of basic pay for a four-year enlistment where promotion rates are constant throughout and (v) (RMWP 1) a wage series using the present value of basic pay plus BAS and BAQ for a four-year enlistment where promotion rates are constant throughout. As is shown in Section IV, the last four wage series have moved relatively similarly over time. The correlation between wage series (ii) used in the above analysis and the two present value series using constant promotion rates, iv and v, is greater than 0.90.

The estimated wage elasticities for white male high school graduates AFQT I, AFQT II, and AFQT III using the alternative wage series for the time period 1959-1967 are given in Table 3. The results for AFQT I-II and AFQT I-III combined have also been included. The first column of wage elasticities are Cook's estimates. The series used above, RMC, gives results for white males that are quite similar to those obtained using Cook's series, RMWC, and to those actually obtained by Cook, where he studied all enlistees in categories I through III.

Table 3. Estimated wage elasticities using alternative relative wage series, 1959-1967.

Cohort	Without G.I. Bill			With G.I. Bill			
	Cook's Estimate	RMWC	RMC	RMC	RMWE1	RMWP1	RMWP2
WMH1	2.36	2.44	2.93	3.06	2.32	1.69	1.97
WMH2	N.A.	1.82	1.83	1.11	-1.61	-1.40	-1.28
WMH3	N.A.	1.52	2.67	2.21	-0.91	-0.98	-0.83
WMH1-2	2.15	1.95	2.06	1.54	-0.68	-0.70	-0.53
WMH1-3	2.23	1.77	2.30	1.80	-0.77	-0.82	-0.65

The most important result is the difference between RMWP1 and RMWP2 when compared to RMC or RMWC. The only difference in RMWP1 and RMWC is that RMWC includes the actual promotion rates in the Air Force and RMWP1 is calculated using constant promotion rates. It is conjectured that the reason that the RMC wage series gives results similar to Cook's series is that it also includes the actual pay grade distribution.

The other result of interest is that the elasticity estimate for AFQT I is positive and quite large. Indeed, all of the elasticities are larger than those obtained over the whole period using the RMC wage series.

Given these results, the sensitivity of the wage elasticities to alternative relative wage series over the entire period is examined. These results are given in Table 4. The RMC wage elasticities are those reported previously. The

Table 4. Estimated wage elasticities using alternative relative wage series, 1956-1977.

Cohort	RMC	RMWP1	RMWP2
WMH1	-0.17	-0.40	-0.85
WMH2	0.54	-1.08	-1.29
WMH3	1.76	-0.06	-0.06
WMH1-2	0.44	-0.88	-1.10
WMH1-3	1.05	-0.48	-0.61

wage elasticities using a constant promotion rate are negative for AFQT categories II and III as they are for 1959-1967. These results strongly suggest that the choice of a measure for real military wages is crucial. Furthermore, it appears that changes of the promotion rate over time are important.

These regressions can be run in the first differences with an adjustment made to correct for the autoregressive structure introduced by the differencing. When this is done, the short term movements in the series are emphasized rather than the long term trends. Estimating this way all three wage series now give wage elasticities that are positive for the AFQT II and AFQT III cohorts. The point estimates are closer to zero, which they should be if the first-difference regressions yield what is primarily an estimate of the short-run elasticity. Since the signs of all three wage series are the same in the first difference equations, this suggests that the negative signs in the level regressions are a result of differences in the long run trend behavior of the alternative wage series. That is, the important differences in the two series are probably due to the long-run changes in promotion rates.

In contrast to Cook, R. V. L. Cooper has estimated wage elasticities for DOD, male, high school graduates, AFQT I-III accessions using an assumption of fixed promotion rates during the period 1970 to 1976 (Cooper, 1977). The wage series that he used is similar to the RMWP2 above. Cooper obtained an estimated wage elasticity of about 1.1. The major difference in his approach is that he adjusts the enlistment series to a "true volunteer" series for the period prior to 1973 rather than using actual volunteers and including draft variables in his regression equation as done here. Table 5 presents the results of estimating the accession supply equation during the same time period Cooper used and extended to the end of the sample period. Similar to Cooper, these regressions do not include the G. I. Bill.

The results are similar to those obtained above in that the RMWP1 and RMWP2 tend to give negative wage elasticities while, except for AFQT I, the RMC wage series gives positive results. The reason Cooper obtains a positive sign using a wage series with constant promotion rates is probably due to the way he estimated "true volunteers." Cooper assumed that accessions with lottery numbers greater than 240 could be used to estimate the true volunteer rate that would exist without a draft. His true volunteer measure was found by multiplying the number of accessions with lottery numbers greater than 240 by 365/125. If, however, the high quality draft-induced accessions are competing with the AFQT II and AFQT III accessions for good schools and assignments, then his measure of true volunteers will underestimate the number of accessions that would have occurred without a draft.

That is, some AFQT II and AFQT III individuals with lottery numbers greater than 240 might decide not to volunteer because high quality draft-induced volunteers have filled the good assignments. Clearly, the large incidence of accessions with some college during this period is consistent with this hypothesis.

A comparison of the results in Tables 3, 4, and 5 also reveals that considerable differences in the point estimate of the wage elasticity are obtained from different time periods. For example, during the 1959-1967 period, using the RMC wage series, the AFQT I cohort has a positive 3.06 estimate for the wage elasticity and the AFQT II estimate is 1.11. During the full sample period, this same wage series yields point estimates of -0.17 and 0.54 for the AFQT I and

Table 5. Estimated wage elasticities using alternative relative wage series.

Cohort	1970/3 - 1976/2			1970/3 - 1977/4		
	RMC	RMWP1	RMWP2	RMC	RMWP1	RMWP2
WMH1	-2.83	-1.20	-1.96	-3.26	-1.51	-2.37
WMH2	0.11	-0.69	-0.88	1.58	-0.04	-0.04
WMH3	1.32	-0.50	-0.55	2.38	0.04	0.23
WMH1-2	-0.25	-0.76	-1.01	0.96	-0.23	-0.26
WMH1-3	0.41	-0.65	-0.82	1.59	-0.10	-0.03

AFQT II cohorts, respectively. Similarly, in Table 5, the addition of 2 years to the sample period greatly increases the magnitude of the estimated wage coefficients.

The above analysis suggests that even though the results are not very sensitive to functional form specification, the same is not true with respect to the choice of sample period or the choice of a wage measure. It is not clear why the results are so sensitive to the choice of sample period. However, the above results do suggest a reason for the differences obtained between the alternative wage series. A correct wage series would explicitly take account of the changes in the Air Force promotion rates. Data for pay grades by length of service is not currently available for the 1956-1977 time period. Therefore, the RMC series will

continue to be used as a proxy for the correct series but it must be kept in mind that the use of RMC may introduce a bias into the results. Since it is not known why the choice of sample periods results in the observed differences, the full sample period will continue to be used to obtain the wage elasticities. This makes use of the full information available and should, other things equal, provide the best point estimates.

Except for the 1959-1967 period, the point estimate for the white male, AFQT I cohort is negative. Although it could be that a wage series that explicitly used the promotion rates for AFQT I's would reverse this sign, at this time this is merely a conjecture since it is not known why this cohort yields a negative point estimate for the wage elasticity. Alternative specifications, with adjustments for the increased percentage of college graduates during the Vietnam War and the large increase in six-year enlistees during the early 1970s were tried and did not change the results for this cohort.

Model with Mean Wait Endogenous

Up to this point in the analysis, any potential effect of the queue on accession behavior has been ignored. To the extent that changes in the length of wait to enter the Air Force are empirically important, the wage elasticities presented above may be biased. The effect of the queue is empirically examined during the period for which we have a paydate in the primary records and can calculate a mean length of wait. The method of two-stage least squares (2SLS) is used over the time period 1966-1977. In stage one, the expected wait is estimated using the following equation.

$$LQAH_i = \beta_o + \sum_{j=1}^{17} \beta_j X_j + \beta_{18} LTFOR + \beta_{19} LWMP + \beta_{20} LMJOB + \beta_{21} LMOBJ, \qquad (9)$$

where X_j, j = 1, 17, are the variables used in the ordinary least squares regression that are relevant to this time period. $LQAH_i$ is the mean length of wait for cohort i. The four additional variables are variables which have an independent effect on the mean length of wait. LTFOR is the log of the total force, LWMP is the log of the white male population, LMJOB is the log of the male delayed entry objective and LMOBJ is the log of the male recruit objective.

For the second stage, the estimated $\hat{LQAH}_i$ from the first stage equation is used together with the variables used in the ordinary least squares regression that are relevant to this time period.

For the AFQT II and AFQT III cohorts, the coefficient for the mean wait is negative, as predicted, but is small in magnitude and has a t-ratio of less than one. A comparison of the 2SLS results with the OLS results for these two groups shows that the mean wait constant wage elasticities are somewhat smaller than the OLS wage elasticities, which is also

consistent with the theory. The other coefficients in the two equations are similar. The 2SLS regression for the AFQT I cohort is more difficult to interpret since the OLS regression over this time period has a positive point estimate, and the 2SLS estimate is negative.

The finding of a relatively insignificant effect for the mean wait can, in part, be accounted for by the actual workings of the delayed enlistment program. When the new jobs are opened, not all of the jobs in a given month are offered at the same time. Some jobs for each month in the future will be opened every month. In this sense, it is not really a first-come, first-serve structure. Even though there may be no openings today for a future month, openings will occur for this future month at a later date. It is therefore always possible to bring in some people without any undesired wait by allocating the newly opened jobs to these people. It is not clear to what extent this sequential opening of jobs may be used to enlist people who would otherwise balk.

Estimates Using Across Equations Constraints

Given the relatively insignificant empirical results for the mean wait in the two-stage estimations, the mean wait will not be included as an endogenous variable. Tests are now conducted to determine if the point estimates obtained for the six male cohorts are significantly different. These tests are conducted by imposing constraints across the individual regression equations. The method of estimation used is the seemingly unrelated regression method which uses the information contained in the correlation between the disturbance terms from the separate equations. Using this information will provide estimators that are more efficient than the OLS estimators.

The first test conducted is to examine whether all males AFQT I through AFQT III have the same wage elasticity. This hypothesis is rejected at the 5 percent level of significance. The next test is to determine whether the black and white male wage elasticities are the same within each cohort. The hypothesis of no difference is accepted at the 5 percent level of significance. That is, no differences are found between the black and the white male cohorts of the same AFQT.

The final test determines if, given that there is no difference between the races by AFQT cohort, the wage elasticity of the AFQT I cohort is different than that for the AFQT II cohort and if the wage elasticity of the AFQT II cohort is different than that for the AFQT III cohort.

A test of whether the male AFQT I elasticity differed from the male AFQT II elasticity, given that black and white

males are the same within all three cohorts, shows no difference at the 5 percent level of significance. A test of the hypothesis that the AFQT II and AFQT III categories have the same elasticities results in rejecting the hypothesis at the five percent level that these two cohorts have the same wage elasticity. Combining these results, the best estimates will be obtained by constraining the wage elasticities for black male and white male cohorts to be the same and constraining AFQT I to equal AFQT II. The six equations are then estimated as a system. This yields a point estimate of 0.414 for the wage elasticity of males AFQT I or AFQT II and a point estimate of 1.513 for males AFQT III. The corresponding standard errors are 0.649 and 0.669. Given the small value of the point estimate for AFQT I and AFQT II, the t-ratio is less than 1.00. For AFQT III, the t-ratio is 2.25.

Conclusions

A number of substantive results about the behavior of non-prior service enlisted accessions are reached. The basic theoretical structure which hypothesizes that quality is endogenously determined is confirmed. The regression results for the non-high school graduates, AFQT category IV and for the females provide evidence consistent with demand limitation in these cohorts. In addition, the wage elasticities obtained are shown to be quite robust with respect to changes in functional form. Furthermore, the 2SLS estimates suggest that the queue is not an empirically important factor in accession supply.

For the male, high school graduates, AFQT categories I, II, and III, demand limitations do not appear to be present to any serious degree. The black and white males are found to have similar wage elasticities with a point estimate of 0.414 for the AFQT I and AFQT II categories and a point estimate of 1.513 for AFQT category III. The differences between the AFQT categories I and II compared to III are statistically significant. Since the AFQT III category has a different (higher) wage elasticity than the other two categories, one should not group the top three AFQT categories together for estimation purposes as other studies have done.

The results presented strongly indicate that the choice of a military wage series is important. Furthermore, the evidence from both the level regressions and the first-difference regressions suggest that the longer term changes in the promotion policies are important elements of the military wage package. The results obtained for the point estimates of the wage elasticities are sensitive to the particular time period selected. Therefore, some caution must be exercised when comparing the point estimates presented with those contained in other studies which only use a sub-period of the sample used here.

VI. AIR FORCE MANPOWER AND ITS RELATION TO SKILLS MARKETS

The previous sections have treated Air Force manpower as being homogeneous. That is, the analysis concentrated on the overall accession and retention problem and ignored the differences in the Air Force's ability to acquire and retain individuals in specific specialties. To some extent, this section will rectify this omission. Specifically, here it is assumed that the manpower pool is divided into a number of sub-pools, each of which comprises a specific skill or aptitude to acquire that skill. Accordingly, the analysis consists of individual skills markets. The overall market for Air Force enlisted personnel is then composed of several of the component skills markets.

The disaggregation in combination with meeting overall force level goals will imply that in some skills markets quality levels may be considerably below desirable minimums while in others, quality levels may be above desired minimums. Or alternatively, if the minimum quality standards are strictly adhered to, then shortfalls will occur in some skills while excess manpower will exist in others. The greater the latitude the Air Force has in managing the pay and promotion opportunities by skill class, the smaller this problem. What the analysis in this section accomplishes is an explicit statement of this problem and its relation to the overall accession and retention problem. In effect, this work lays the groundwork for a skills market approach to modeling Air Force manpower procurement.

The Basic Model

The Air Force is composed of 254 3-digit specialty codes that can be aggregated into clearly delineated skill groupings. These skill groupings have different minimum quality requirements. Of the total net arrivals for enlistment to the Air Force during any given interval, not all arrivals will take any Air Force job offered, and the Air Force will not take all individuals in any particular job. Thus, a simultaneous sorting problem must be solved where arrivals sort themselves over jobs and jobs are sorted over arrivals.

From our previous theory, the rate at which individuals that are both interested in a certain skill group and meet the qualifications for that skill arrive for enlistment depends on wages (both civilian and military) and the qualifications required in that skill group. The greater the military wage or the better the promotion possibilities, the greater the rate of enlistment. On the other hand, civilian wage changes have the opposite

impact on enlistments. In particular, the greater the civilian wage for given military opportunities, the lower the enlistment rate in that skill group.

The structure of Air Force minimum qualifications also impacts significantly in the enlistment rates for any particular skill group. Raising the standards for a particular skill group will result in a spillover effect on those skills with lower qualifications thereby raising enlistment rates in the lesser skills and lowering enlistment rates in the skill group with higher standards. On balance, any raising of standards will reduce the total flow of enlistees implying that the increase in enlistments in the lesser skill group will be more than offset by a reduction in enlistments in the skill group with higher standards.

In addition to the structure of enlistments, the length of stay in each skill group is important in that it determines for a given force level how many new recruits are required to maintain the manpower pool. The greater the mean length of stay in the Air Force, the smaller the flow of new recruits required. In effect, the mean length of stay is like the size of a drain in a bathtub. The shorter the length of time the average recruit spends in the Air Force, the faster water runs out of the tub and, accordingly, the faster new water must be added to maintain the water level.

The Air Force does not allow each recruit to choose a desired length of stay nor are slots in skill groups always open for all who qualify. Thus, at times individuals who otherwise qualify will be turned away or forced to wait because all slots are full. Some of these individuals will spill over to other groups but on net some are lost forever. The greater the benefits of the Air Force relative to comparable civilian work, the longer prospective recruits will wait for a slot in their desired skill group. The net effect of these factors can be expressed in the probability of a randomly chosen prospective recruit actually enlisting in the Air Force. This probability will be greater the greater is the Air Force wage, the lower are civilian wages, the shorter the wait for slots to open, the greater the unemployment rate.

Equilibrium in the Skills Markets

The rate at which individuals actually enlist in a given skill group depends on the total number of prospects and the probability that a randomly chosen prospect will actually enlist. The rate of new enlistments desired by the Air Force for any skill group depends on the size of the desired manpower pool in that group and the length of the average tour of duty. These factors simultaneously determine

the quality of the manpower pool in each of the skill groupings.

Given that the force level for each skill group is fixed, then quality of recruits must adjust so that the number of recruits matches the number leaving the Air Force. In general, increasing the desired force level in a specific skill group will reduce the quality in that group and all lower skill groups since the increased demand for recruits will be met partially by prospects who would previously have enlisted for less skilled jobs. Increases in the promotion rates or the levels of pro-pay in a specific skill group will increase quality in that group and reduce quality in all others. Increases in civilian opportunities for any skill group have exactly the opposite impact on quality as increased Air Force opportunities.

Thus, if the Air Force chooses a fixed composition of the total force by skill level, then the quality composition of the force cannot be chosen with fixed wages and promotion rates. Specifically, assuming that for each skill group, a fixed force level is maintained then the number of new accessions must equal the number leaving the force over any given period of time. The equalibrating force in this approach is the quality level of the recruits. For example, the discussion above suggests that an increase in the desired force level for the ith skill group will increase the number of accessions in the ith skill group. This increased number of accessions is available because this same increase in desired force level in skill group i decreases the quality standards for all skill groups with equal or lower quality standards. Thus, the increased accessions are being "paid" for by the necessity of accepting lower quality in the skill group with increased manpower requirements.

If, on the other hand, the Air Force wishes to fix the quality standards for each skill group, then it must be prepared to accept shortfalls in the force level in some skill groups. In this regime, an increase in the quality standard for a particular skill group will, if that group had no shortfall at the time, result in a shortfall. For skill groups with lower standards, the spillover from the group with the shortfall will result in excess supply of new recruits. In general, the sum of the shortfall and excess supply will be a total shortfall. That is, not all individuals lost to the skill group with the new higher quality standards will join the Air Force in a lower skill group, but some will.

Increases in Air Force pay opportunities in a particular skill group, e.g., faster promotion or pro-pay, will decrease the shortfall or result in a surplus in that skill group. In other skill groups, however, this same increase in

opportunities will result in an increase in the shortfall or create one where one did not exist before. This effect is the result of a deterioration of the pay opportunities in all groups relative to the skill group with increased opportunities so that individuals will wait for the skill with better opportunities rather than enlist.

Some Simple Graphics of Skill Group Equilibria

To better understand the analysis discussed above, it will prove useful to limit the skill groups to two. Let F_1 and F_2 be the desired force levels in the skill groups 1 and 2. In Figure 15, the demand and supply of new enlistments is presented for both skill groups 1 and 2. Panel A contains the schedules for skill group 1 and Panel B for skill group 2. The horizontal axis in each panel is the level of accessions and the vertical axis is the Air Force wage for the skill group in question.

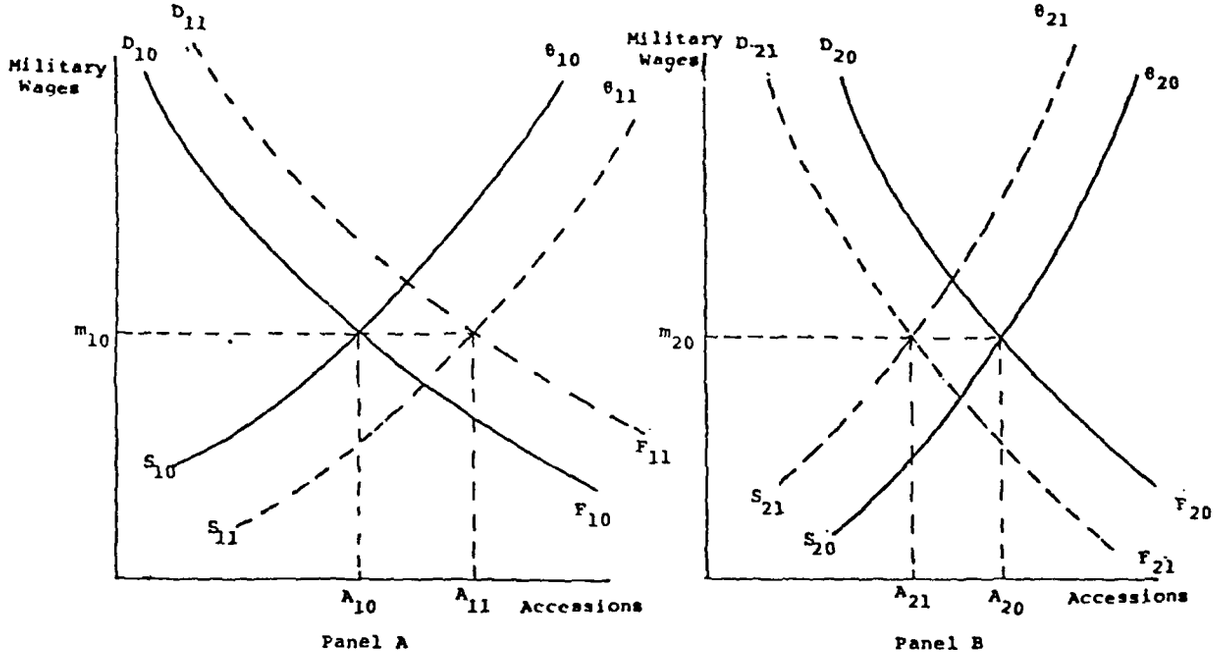

Figure 15. Skills-market equilibria.

The schedules labeled D are Air Force demand for recruits. They are negatively sloped by virtue of an increase in Air Force pay opportunities making the Air Force more desirable so that first-term losses are reduced and turnover falls; thus, any given force level can be maintained with a smaller flow of recruits. The schedules labeled S are supply schedules for new recruits. These supply schedules are positively sloped because increases in Air Force pay opportunities will elicit more potential recruits of a given quality.

For simplicity assume that Air Force pay opportunities are the same for each of the skill groups. As a result, the quality of recruits adjusts until supply exactly equals demand. Letting θ_i represent quality in the ith skill group the equilibrium in Figure 15 occurs at $(m_{10}, A_{10}, \theta_{10})$ and $(m_{20}, A_{20}, \theta_{20})$ where m_i and A_i are respectively military pay opportunities and accession in the ith skill group. Increases in the force level of any skill group will increase demand since the larger force with a fixed turnover rate means a greater absolute number of losses per period. Consider an increase in the desired force level in skill group 1 from F_{10} to F_{11} where $F_{11} > F_{10}$. Given the level of military and civilian wages, this increase in desired force level increases the Air Force demand for accessions shown by the dashed demand schedule in panel A of Figure 15. Since by assumption, both military and civilian wages and civilian employment opportunities are constant, meeting the new desired force level requires that the one remaining variable, quality, adjusts so that the new greater demand for accessions can be met.

The new equilibrium in skill market 1 is the point $(m_{10}, A_{11}, \theta_{11})$ in Panel A, Figure 15. This new equilibrium accession rate is characterized by two important changes. First, minimum quality in skill market 1 has fallen to $\theta_{11} > \theta_{10}$. Second, waiting time has changed but the direction of its change is on the surface uncertain. Two offsetting forces are at work. The lower minimum quality standard reduces the waiting cost and increases the probabilities that any individual will join a queue of a given length. But, the now greater departure rate resulting from the increased force size reduces the expected wait for given net arrival rate.

The desired force level for skill group 2 must be reduced if the overall level of Air Force manpower is to remain unchanged. However, for purposes of pedogogy, it will be useful to analyze this change in two parts. First, leaving the desired force level in skill group 2 unchanged, the lower equilibrium minimum quality for skill group 1 will reduce the arrival rate for skill group 2. This reduction in the arrival rate in skill group 2 is a result of skill group 1 capturing some arrivals from group 2 because of group 1 lower minimum quality. Thus, if the previous accession rate is to obtain, which it must if the force level in group 2 is to remain unchanged, the minimum quality in group 2 must fall. Thus, the original supply schedule in panel B, Figure 15, is now only valid if minimum quality in group 2 is lower.

The second component of the adjustment process is allowing for the reduction in the group 2 force level so that overall enlisted strength will remain unchanged. This force level reduction results in the movement of the group 2

Air Force demand schedule to D_{21} in Panel B. At military wage, m_{20} fewer accessions will be required to maintain the now lower group 2 force level. This lower level of accessions will be available with higher minimum quality for group 2. Thus, there are two offsetting effects on the minimum quality standards for group 2.

If the lower quality standard for skill group 1 simply crowds out arrivals to group 2, then the net change in the minimum quality for group 2 will be zero. This assumption of "crowding out" implies that the minimum quality standards for the Air Force skill groups do not affect the overall Air Force arrival rate. In particular, it implies that the increase in the arrival rate to skill group 1 when its minimum quality is reduced comes entirely at the expense of skill groups with lower minimum quality. This seems a rather extreme assumption in light of the fact that the more desirable jobs belong, in general, in the higher skill groups. Thus, it seems reasonable that a lowering of the quality standards in a skill group will attract arrivals from the population as a whole in addition to those from lower skill groups.

If the lowering of minimum quality standards in skill group 1 does indeed attract some arrivals from the general population who would not have been in skill group 2 arrivals, then the conclusions concerning the equilibrium minimum quality standard in group 2 reached above are wrong. In particular, for a constant overall force level, it follows that the reduction in the minimum quality standards for skill group 1 that results from the increase in the relative size of skill group 1 will increase the overall arrival rate to the Air Force. That is, individuals who would not have entered the Air Force because they did not meet the minimum quality standards for skill group 1 will now enter. Accordingly, the minimum skill level for skill group 2 will rise since, at a given skill group 2 minimum quality standard, overall Air Force arrivals will have risen.

In summary, then, a redistribution of Air Force manpower in the direction of greater emphasis on higher skill groups, with a constant military wage, will reduce quality in higher skill groups while it increases quality in lower skill groups. If the impact of this type of change in Air Force policy is to be correctly evaluated, the interaction between skills markets must be taken into account. It appears then that individual skill group estimates must be done as a simultaneous estimation process if the estimates are to be reliable and useful in determining future requests for manpower and pay.

VII. THE DYNAMICS OF FORCE LEVEL MANAGEMENT

The entire focus of the theoretical work in this report and to some extent the empirical work as well, is that the Air Force is in equilibrium in terms of manpower. In fact, however, some finite amount of time must pass in the movement from one equilibrium to another. Thus, the manpower pool is in a continual state of flux as the parameters facing the Air Force change. The impact of this flux must be kept in perspective in that ample evidence exists that the equilibrium theory can and does explain a large portion of the movements in the enlisted manpower pool over the 1956-1978 period. With this in mind, the following discussion will concentrate on some general problems introduced by the assumption that systems do not remain in equilibrium and do not reach that equilibrium instantaneously.

The approach taken here investigates the essence of the adjustment process. Simple plausible assumptions will be made that are intended to reflect but not exactly model factual evidence on institutional arrangements. The approach begins with a study of the direction of various adjustment processes, as well as the extent to which both direction and intensity of those adjustments depend on the various parameters involved. To organize such an analysis seems to be a natural task before trying to generate actual numerical forecasts.

Of particular interest to the Air Force is what might be called market signals generated by the flow of recruits. For example, a shortfall in the current flow of new recruits may be interpreted as a signal that something is happening in the market for accessions that will require Air Force action if the manpower pool is to be maintained. Of similar interest, a new pay policy might be implemented with the result being increased flow of potential accessions possibly signalling that the new policy will result in a larger or higher quality force. But is the immediate signal generated by the market a good predictor of the long-run impact on the force of any particular policy? The answer to this important question depends critically on the exact policy under discussion.

The Cohort Length of Stay Density

The equilibrium manpower pool and its quality depend on solutions in two connected markets, accession and retention. At any point in time, the flow of enlistees into the Air Force is composed of many different desired lengths of stay. One way of describing this feature of an entering cohort is as a frequency distribution. Such a frequency distribution is very much like a probability distribution in that it can be constructed so that it can be interpreted as showing the proportion of all accessions that have desired lengths of stay between say one and two years. The exact form of this distribution depends on the market parameters facing the Air Force.

Considerable insight into the effect of changes in Air Force policy on the manpower pool in the short and long run can be had by assuming a particular form for the length of stay density function.

For illustrative purposes, let the desired length of stay density function be of the form

$$\alpha\tau e^{-\beta\tau} \tag{10}$$

where τ is the desired length of stay and α and β are parameters that depend on military and civilian pay opportunities. An example of such a function is presented in Figure 16. The number of accessions having desired length of stay between τ_0 and τ_1 years is the shaded area in the figure. The total number of accessions α^* is the area under the curve between the minimum enlistment period M and the maximum length of stay R and is represented by the equation

$$\alpha^* = \int_M^R \alpha\tau e^{-\beta\tau} d\tau. \tag{11}$$

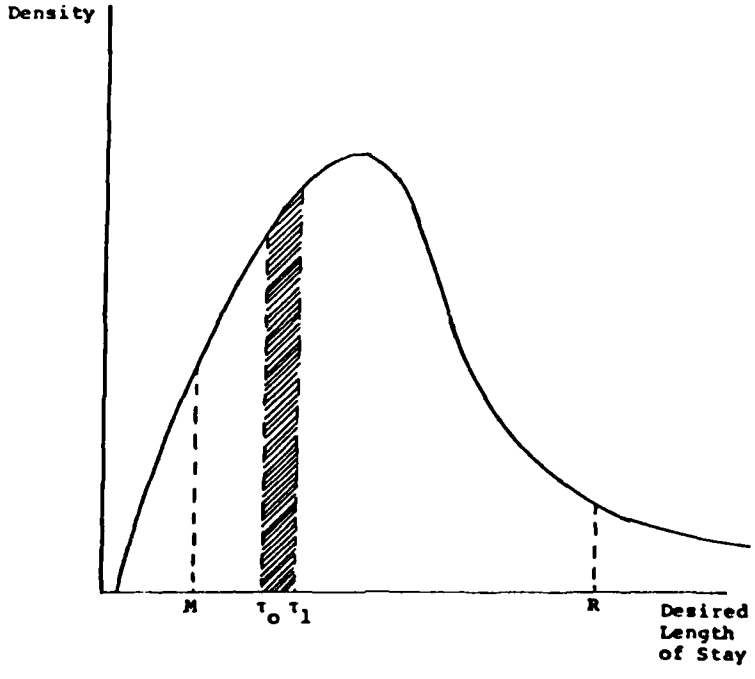

Figure 16. Sample density function.

From the discussion contained in sections 2 and 3 and the form of the length of stay density function, increases in military pay opportunities increase α and reduce β. These two changes in the density function result in an increase in both the number of accessions and the mean length of stay. Accordingly, an increase in military pay opportunities will increase the force size or increase the quality of the force for a given force size. Of course, such a change has only a small initial impact and considerable time elapses before the change works its way through the system and a new equilibrium is achieved.

The Dynamic Adjustment Process

The manner in which changes in the parameters work their way through the system is referred to as dynamic adjustment. Given that no parameters change during the adjustment period, the adjustment will be completed in R periods. At that time, all the cohorts in the force will have had identical length of stay density functions when they entered. Thus, the force will be in equilibrium in that its composition will remain unchanged from that point on. Of particular interest is how this new equilibrium is achieved and its relation to the original equilibrium.

To gain some feel for these adjustment processes and their relation to manpower planning problems, consider a fall in Air Force pay that affects all new recruits throughout their careers but does not affect existing members of the force. In this example after R years, all members of the force will be on the new pay scale. In order to simulate the exact adjustment process assume that the initial value of α is 30,000 and β is 0.45. At these levels, the force size is approximately 481,000 and the mean length of stay is approximately 7 years. Let the changes in Air Force pay opportunities result in a value for α of 29,000 and β of 0.465 so that the equilibrium force level falls to approximately 412,000 and the new mean length of stay to approximately 6.9 years.

Using the cohort length of stay density the dynamic adjustment path can be calculated for these values of α and β. This adjustment path is presented in Table 6 . Column one of the table presents the year that the levels of the variables presented are observed. Column two contains the force level at the end of the year in question (the end of year 0 is the beginning of year 1). Column three contains the rate at which the force level is changing at the end of the year in question (this number is <u>not</u> the actual difference between the force levels in two successive years since the rate of change changes continuously throughout the year except for years 0-4). Column four contains the percentage rate of growth in the force level.

Table 6. Dynamic adjustment to decrease in military pay.

Year	Force Level	Rate of Change	Percent Growth Rate
0	480,972	-8,854	-1.841
1	472,118	-8,854	-1.875
2	463,264	-8,854	-1.911
3	454,410	-8,854	-1.948
4	445,556	-8,854	-1.987
5	437,571	-7,140	-1.632
6	431,211	-5,616	-1.302
7	426,260	-4,328	-1.015
8	422,476	-3,278	-0.776
9	419,630	-2,448	-0.583
10	417,518	-1,805	-0.432
11	415,968	-1,317	-0.317
12	414,843	-952	-0.229
13	414,033	-682	-0.165
14	413,454	-485	-0.117
15	413,044	-343	-0.083
16	412,755	-241	-0.058
17	412,552	-168	-0.041
18	412,411	-117	-0.028
19	412,313	-81	-0.020
20	412,246	-55	-0.013
21	412,200	-38	-0.009
22	412,169	-26	-0.006
23	412,148	-17	-0.004
24	412,134	-11	-0.003
25	412,125	-7	-0.002
26	412,119	-5	-0.001
27	412,115	-3	-0.001
28	412,113	-1	-0.000
29	412,112	-1	-0.000
30	412,112	0	0.000

From the table, it is clear that for the type of change under discussion, the force level adjusts in the same direction at a decreasing rate until the new equilibrium is reached. In Figure 17, this adjustment is shown graphically. The table and the figure make it clear that

(i) The force level F(t) falls continuously although not at the same rate, throughout the adjustment period.

(ii) The absolute value of the proportional rate of change jumps immediately to 1.84 and then steadily rises until t = M (the minimum enlistment period) and then declines.

(iii) The absolute rate of change in the force level F(t) is constant from $0 \leq t \leq M$ and declines thereafter.

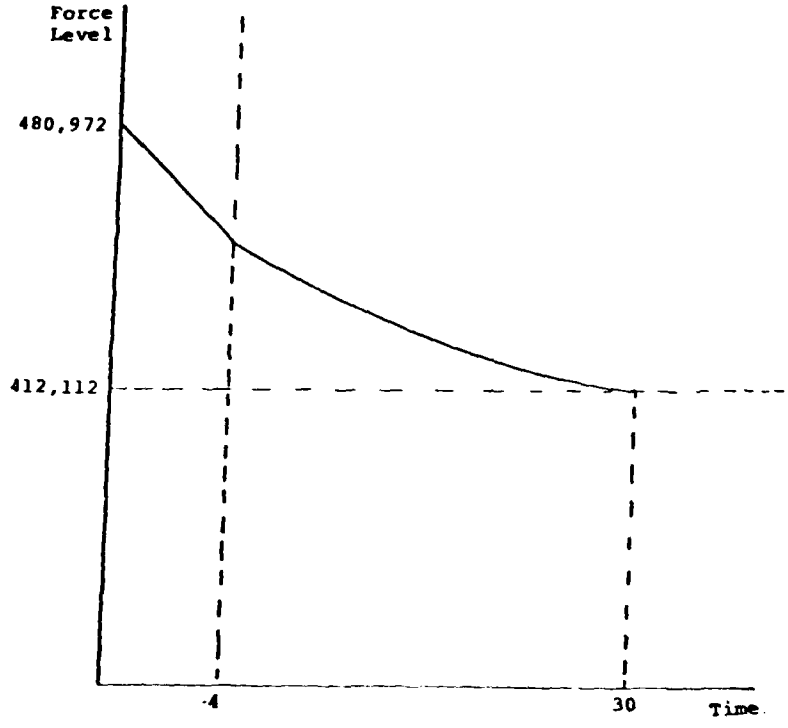

Figure 17. Dynamic adjustment of force level.

Both Table 6 and Figure 17 depict a nice smooth adjustment from one equilibrium to another. They indicate that the signal that a shortfall in accessions required to maintain the force level at its previous equilibrium implies a long-run problem would be a correct conclusion. But, is this simple interpretation of the immediate response always the correct one? Can a reasonable scenario be constructed such that the initial response to a change gives the wrong signal?

To address these questions, consider the current G. I. Bill which promises certain payments after separation from the military upon completion of at least M years of service. This compensation scheme increases the returns to enlistment and reduces the returns from remaining in the military longer than M years. Thus, it can be expected to increase accessions and reduce the mean length of stay so that offsetting forces are at work. The real question is whether the force which prevails in the short run also prevails in the long run.

The answer to this important question can be had by considering the initial levels assumed for α and β of 30,000 and 0.45 respectively. Now let the new G. I. Bill result in an increase in α to 43,500 and an increase in β to 0.5. The net effect will be an increase in accessions and a decrease in mean length of stay from 7.0 to 6.7 for those entering the Air Force. Table 7 and Figure 18 present the dynamic adjustment for this scenario. The results are rather startling and a bit disconcerting to anyone who believes short run signals.

Table 7. Dynamic adjustment to the Introduction of a G. I. Bill.

Year	Force Level	Rate of Change	Percent Growth Rate
0	480,972	2,079	0.432
1	483,051	2,079	0.430
2	485,129	2,079	0.428
3	487,208	2,079	0.427
4	489,287	2,079	0.425
5	489,809	-756	-0.154
6	488,243	-2,185	-0.447
7	485,743	-2,699	-0.556
8	483,020	-2,684	-0.556
9	480,463	-2,401	-0.500
10	478,251	-2,015	-0.421
11	476,435	-1,620	-0.340
12	474,999	-1,261	-0.266
13	473,894	-958	-0.202
14	473,063	-714	-0.151
15	472,447	-524	-0.111
16	471,999	-380	-0.080
17	471,676	-272	-0.058
18	471,446	-192	-0.041
19	471,284	-135	-0.029
20	471,171	-94	-0.020
21	471,092	-65	-0.014
22	471,039	-44	-0.009
23	471,002	-30	-0.006
24	470,978	-20	-0.004
25	470,962	-13	-0.003
26	470,952	-8	-0.002
27	470,945	-5	-0.001
28	470,942	-3	-0.001
29	470,940	-1	-0.000
30	470,939	0	0.000

The adjustment to this change involves an initial increase in the force level caused by an excess of accessions over losses. But as these new accessions reach the end of their first tour of duty, they leave the force in greater numbers, swamping the increased rate of accessions and resulting in a reduction in the force level. In fact, the new equilibrium force level falls by some two-tenths of one percent. The brief excess of accessions, if it leads to complacency in the recruiting process, will in this case cause substantial problems later on. Any evaluation of policy must account for the difference between short- and long-run effects.

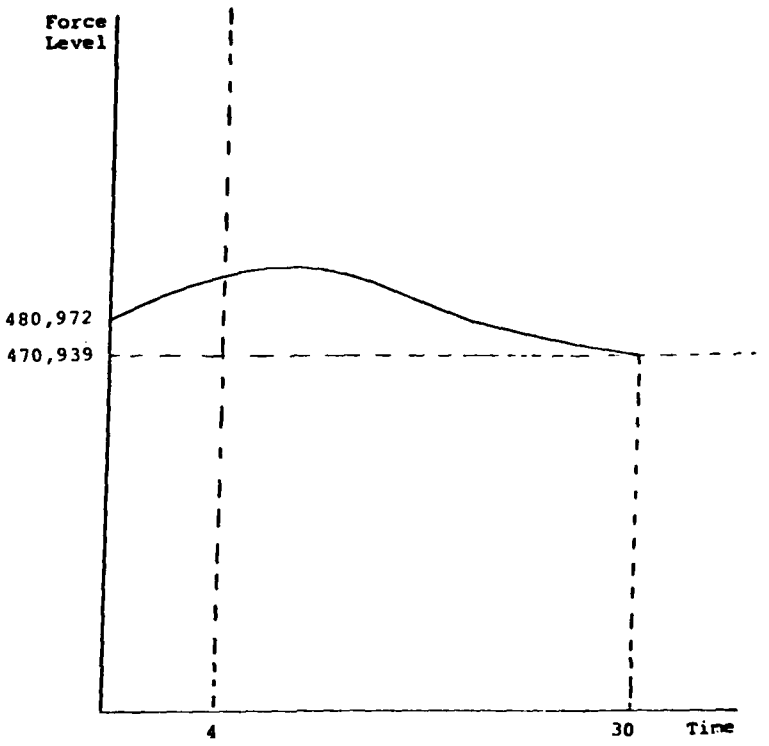

Figure 18. Dynamic adjustment of force level to introduction of G. I. Bill.

Some Concluding Remarks

Admittedly, the adjustment process constructed in this section is highly contrived. It does, however, have the properties of the theoretical discussion of Sections II and III Additionally, it makes it abundantly clear that both the effect on retention as well as the effect on accession of any policy must be considered before that policy's long-run impact can be assessed. Long-run effects are not necessarily the same as short-run effects, and using the short-run impact as a signal of the long run can in some cases lead to totally wrong conclusions.

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Errata

Number	First Author	Title
~~AFHRL-TR-80-7 (AD-A090-535)~~	~~Skinner~~	~~Performance of Retrained Airmen in Air Force Technical Schools~~
AFHRL-TR-80-12 (AD-A085 658)	Saving	Air Force Enlisted Personnel Retention-Accession
~~AFHRL-TR-80-60 (AD-A097-353)~~	~~Friedman~~	~~Adaptive Testing Without a Computer~~

Due to norming problems encountered with ASVAB Forms 5, 6, and 7, percentile scores derived from these test forms are in error. While the relative ranking of individuals by their percentile scores would not be affected by the norming errors, their absolute score values would be different. Therefore, descriptive statistics reported in the subject technical reports above are erroneous; other types of analyses in the report which use ASVAB percentile scores should be interpreted with caution.

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